J. D. Turner

Proceedings

FOURTH ANNUAL MEETING

OF THE

NORTH CENTRAL WEED CONTROL CONFERENCE

AND

REPORT OF RESEARCH COMMITTEE

DECEMBER 10, 11, 12, 1947

MUNICIPAL AUDITORIUM

TOPEKA, KANSAS

1948 MEETING

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PROCEEDINGS

OF THE

FOURTH ANNUAL MEETING

OF THE

NORTH CENTRAL WEED CONTROL CONFERENCE

MUNICIPAL AUDITORIUM

TOPEKA, KANSAS

DECEMBER 10-11-12, 1947

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PREFACE

The proceedings are here presented for the 4th annual meeting of the North Central Weed Control Conference which was held at the Municipal Auditorium, Topeka, Kansas on December 10-11-12, 1947.

Due to lack of space for printing all questions and answers have been deleted from these proceedings to make room for research abstracts which are included in this report.

The total registered attendance at this conference was 631 people from 30 states. On the day previous and the first day of the conference a severe snow storm prevailed which reduced the attendance some and congested hotel accommodations.

In order to conserve space, titles to names as well as agency or organizations represented have in most cases been omitted. These may be found by consulting the alphabetical register or list of attendance located in the back of the proceedings.

The officers, directors and members of the conference desire here to extend appreciation to the following firms who donated generously to assist in financing the activities of the conference during the year and the annual conference meeting at Topeka:

American Chemical Paint Company	Ambler, Pennsylvania
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The Kansas Committee on arrangements consisted of: J. C. Mohler, Roy Freeland, Paul Ijams, W. L. Noe, Fred True, J. L. Hutchinson, Maynard Scott, Robert Guntert and T. F. Yost. Gene Spratt was in charge of publicity, radio, and motion pictures and slides.

Recordings were taken and transcriptions made by use of sound scriber equipment furnished by Corn States Hybrid Service, Des Moines, Iowa, and by Kansas City, Missouri and Topeka, Kansas agencies of sound scriber equipment.

W. W. Worzella, Secretary-treasurer

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FOURTH ANNUAL MEETING

NORTH CENTRAL WEED CONTROL CONFERENCE

Wednesday Morning, December 10

The opening meeting was called to order by President Noel Hanson, who presented Mr. J. C. Mohler, Secretary, Kansas State Board of Agriculture, who in turn introduced Hon. Frank Carlson, the Governor of Kansas.

Address of Welcome by Hon. Frank Carlson, Governor of Kansas:

Mr. Mohler, President Hanson and members of the North Central Weed Conference and friends. I am pleased to be here and meet with this splendid group, and to Mr. Mohler, thank you for the kind introduction.

Since Kansas is the host state to you people of Canada, Minnesota, Nebraska, North and South Dakota, Michigan and other northern states, we wanted to make you feel at home so ordered this blanket of snow. While it makes traveling difficult, it is a great blessing to our state and we are very happy about it.

It was my pleasure this morning to visit the exhibits used for weed control and I observed that much progress had been made over those used on my father's farm. These improvements are indeed a boon to the future betterment of agricultural and economic conditions in the state and in the nation where we have this progress and development. Among the exhibits were the new insecticides, weed-killers and various chemicals which are now being used with fine results. Much of the progress which has been accomplished in this field is due to the efforts of Ted Yost, head of the Weed program in the state of Kansas. I have known Mr. Yost for a long time. He was the County agent in Cloud county and I was president of the Farm Bureau in that county at one time and I appreciate his interest in weed control.

As Governor of this progressive state of Kansas it is a pleasure to bring to you visiting here some of the agricultural achievements of the past year. We have just raised our largest wheat crop, approximately three hundred million bushels. This year in Kansas we are going to have approximately one and a half billion dollars taken from the soil, a quarter billion from mineral and oil and gas, one and a half billion from grain and livestock and approximately a quarter billion from manufacturing products. Over two billion dollars reproduced in new wealth in this state. We are very pleased about this, because it has been achieved through the combined efforts of all the people of Kansas, farmers, industrial people and all the working classes.

I am pleased to have met your president, Mr. Hanson, and want to extend an invitation to visit my office at any time during your stay in Kansas. At any time I might be of service to you in the promotion of your program, I will be glad to help. I thank you.

PRESIDENTIAL ADDRESS

PAST, PRESENT, FUTURE IN THE NORTH CENTRAL WEED CONTROL CONFERENCE
By: Noel S. Hanson

A letter came across my desk a few days ago which, although commercial in nature, bore a message which is rather significant in a dynamic field. These were the words: "Procrastination is the art of keeping up with yesterday. With a little perseverance most of us can manage to become quite accomplished in the above art. Even keeping up with today is not impossible. But, the supreme virtue, the one toward which we all are striving, is the art of keeping up with tomorrow."

I am sure that by this time my colleagues consider my second name to be "procrastination". In general, though, the weed control field has become so dynamic that we are all so engrossed trying to answer the questions that came in the mail yesterday that we hardly have time for the work to be done today nor to plan for tomorrow. Nevertheless, in this talk with you I am going to reminisce a little in the past, try to live in the present, and project a few thoughts into the future regarding the North Central Weed Control Conference.

This is the fourth annual meeting of this group. The first meeting was held in Omaha in 1944. At that time we had 91 persons registered. The program dealt largely with cultivation and cropping experiments and the use of sodium chlorate and borax as herbicides. Mr. Kephart had had a look into the growth regulator window and he made some startling predictions, many of which have since come true.

In 1945 the conference was held at St. Paul, Minnesota with 191 persons registered. The 2,4-D bug had bitten the group and most of the time was spent in discussing the experiments conducted over the region under the Uniform Plan of Experiments prepared by the Research Committee. Most of us were throwing parts per million of 2,4-dichlorophenoxyacetic acid around as if we knew what it meant. Doctor Kraus told us "you ain't seen anything yet" and hinted that the War Department was carrying on herbicidal work with the growth regulators. Fortunately, with the war over much of that excellent work has since been published.

In 1946 we went to Des Moines where 260 were registered. Again we talked 2,4-D and the dinitros got a little attention. The information that has been reported in the Proceedings of the last two years has been invaluable. A few of these Proceedings are still available.

This year we are fortunate in having the opportunity to meet here in Kansas where an active weed program has been conducted under Ted Yost's supervision for ten years. Much of the good information on research has come from Kansas from Timmons at the Hays Station, from Krumbaker, Bruns, and Woestermeyer at the Canton Station, and from Professor Zahnley and George McCall at Manhattan.

The program which Ted Yost and his committee have prepared is an impressive one and one which all of us will find interesting I am sure. Again we will hear a great deal about 2,4-D, but we will also have an insight into what

is new and what new chemicals show promise for the future. One of the greatest accomplishments in the herbicidal field of all time has been accomplished this year. It is that of low gallonage application which will be discussed on Friday morning. You men, Longcoy and Shreve of Aerial Insecticiding, Hall and Hess of T. V. A. who have developed airplane spraying equipment; Waters, Meadows, and others of Sherwin-Williams; MacDonald of Peavey Elevators; Barrons, Southwick, and others of Dow; Brandes of Agricultural Supply; Zorsch of Standard Agricultural Chemicals; and anyone else who has been instrumental in the development of low gallonage ground equipment are to be congratulated on a job well done. Further development of application equipment is needed, and we know that there are several manufacturers representatives here who will be greatly interested in the equipment discussions. We are happy to welcome a new section to the conference this year -- that of Weed Control in Horticultural Crops. Many of us are prone to think of the North Central States as the Corn Belt and wheat growing region of the United States. We also have a large vegetable crop and canning industry in this area. The sugar beet and potato industries are extremely important in the north central states as is also the nursery industry. We are most happy to have these people with us and hope that they become an integral part of the conference from now on.

This noon we are honored to have a representative of world affairs with us, and I know that Doctor Kirk can tell us many things that are mighty important regarding the production of food which is so greatly needed in a starving world. Doctor Kirk was for many years instrumental in furthering weed control in Canada, so he knows where this field fits in the food production picture.

Now to project our thinking into the future for a few minutes. You all no doubt have seen the slogan, "The future belongs to those who plan for it." While I hold no brief for the product sold under this slogan, I do believe these words hold a lot of meaning. The future in any field holds much uncertainty at a time as now when conflicting ideologies and hungry people run rampant in the world. Nevertheless, the outlook in the field of agricultural chemicals of which the herbicidal field is an integral part was never brighter. A new and broad field of research and education has been opened which will require the services of hundreds of trained men. Much information has been compiled, but for every question that has thus far been completely answered, hundreds of questions are still unanswered, and only time and diligent research will answer them. Since the advent of 2,4-D, weed research men who in this area are primarily trained in Agronomy and Botany have been called on to answer hundreds of questions for which Plant Physiologists, Chemists, and Agricultural Engineers will also have to supply the answers. Closely controlled experiments will have to be conducted over several years before we have adequate information as to the beneficial or destructive effects of the new herbicides on crops. So far, that information is only general.

We know little for sure as yet regarding the effect of the newer herbicides, including 2,4-D on soils and on the micro-organisms in those soils which must support our agriculture for centuries to come. Greater facilities and more trained men are needed to supply those answers. We are all looking with hopefulness toward the new Research and Marketing Act as a possible source of funds for expanded research on weeds. A committee from this conference has been appointed to work with Director Volk of Purdue University on preparation of projects to come under this act. Doctor Willard, who is also vice-president of this conference and chairman of the Policy Committee, is acting chairman of the Weeds Committee under the Research and Marketing Act for this area.

We are happy to learn that the U. S. Department of Agriculture has received funds for expansion of studies in weed control. We hope their program can be expanded still further and that eventually Regional Weed Laboratories can be established in several areas in the United States.

As the field of weed research broadens, it assumes the proportions of a new science, consisting of the investigation of weeds, their life cycles, their habits, and their control, comparable to similar investigations in other fields of pest control, which are already well-established sciences. Similarly, the new field of investigation and classification of information deserves a scientific name to give it stature along side similar fields. It should be within the scope of this and the other two organized conferences in the United States and Canada to establish such a name. One might consider the origin of the word "weed" as a source of the word stem for the scientific name. This is found to be the Anglo-Saxon word "Weodos." If this word were to be attached to the suffix "ology," meaning science, we would have the word "Weodology." This term is not suggested as a name, but is merely stated to stimulate discussion. I hope you will discuss this matter among you and give us some suggestions as to whether you favor a scientific name other than weed control, which is not inclusive of the whole field. The matter will no doubt have to be left to a committee for further study and will need to be taken up further with the other two conferences.

The matter of a national weed publication has been under consideration for some time, and the possibilities are being investigated. It has been proposed that such a publication be written in popular to semi-technical style and serve as a publication outlet for the research, education, and regulatory phases of three organized weed conferences and would be sponsored jointly by them. If you have not already done so, will you be sure to register your vote regarding this publication at the registration desk.

The field of education in weeds and their control was never more important than at present. With the whole agricultural chemical industry descending on the farms of the world with new methods and with new practices combined with the older methods, the farmer finds himself in the midst of a scientific field for which he has little or no training but in which he is vitally interested. Consequently, adult education is of great importance and these new methods should also go into the school and college curricula as rapidly as they are established and proven. The Agricultural Extension Service, whose job is largely adult education in agriculture, and the regulatory departments in those states and provinces having full scale weed programs are at present carrying the brunt of the load in trying to keep the public informed of new developments in the herbicidal field. This is not easy because many questions cannot as yet be adequately answered with the information at hand. As more information becomes available and new methods become established, the Extension Service will have to keep the agricultural public informed. With increased numbers of products for specialized uses arising from industry, there will be greater need for regulation and the regulatory departments will have increased activities. The programs of the education and regulatory departments can never and should never be entirely divorced from one another, and much good can come from a fully integrated relationship between these two agencies and in turn with research. A vitally interested public is clamoring for information not only about weed killers, but about insecticides, fungicides, and fertilizers which all go to make up the agricultural chemical field. It behooves all of us

who are engaged in State and Federal weed activities to see that the interested public is kept abreast of the latest information and definitely point out that while this information may to some extent be inadequate, it is the best that we have at present. In this way we can keep the farmers thinking with us rather than against us. Anyone engaged in the adult education field will find that the press and radio folks are always ready to cooperate and will do so in fine manner if they, too, receive cooperation. Let us not forget that "cooperation is a two-way affair."

New educational programs in weeds should be so planned as to include weeds other than those classified as noxious. Weed control in cities is important as well as on the farm. Much of the suffering due to hay fever results from ragweed, marsh elder, kochia, and pigweed growing on vacant lots in towns as well as along country roads and non-agricultural areas. While 90 per cent of all hay fever due to plants is traceable to ragweed, there are 35 species that commonly cause hay fever. A poll taken in the middlewest in 1947 showed that out of 5,000 individuals interviewed, one out of ten was allergic to some substance as diagnosed by his physician. Of the plants producing pollen causing allergies, the largest percentage are susceptible to and can be controlled by timely sprays with 2,4-D. Many of the plants causing dermatitis and some of those classed as poisonous to humans and livestock are susceptible and can be destroyed by presently known methods. Untold human suffering and loss in income can be prevented by proper utilization of the information we already have by a fully informed people.

The whole weed control field should be geared to emergency conditions for the next several years while there is such tremendous need for food. Had we all been ready to move at the right time this year when the corn fields of the entire corn belt were being devastated by weeds and drouth, anywhere from 200 million to 300 million more bushels of badly needed corn could have been stored in the corn cribs of this North Central region this fall. Many of you are familiar with the story of one million bushels additional production of corn from 18,000 acres in the Ohio River bottoms near Henderson, Kentucky this year. The same was true in other parts of the corn belt as well. We estimate that better than 50,000 acres of corn were sprayed in Nebraska in 1947. From 11 to 49 per cent increases in yield were measured and recorded in some of these fields. Even a 10 per cent increase in yield in all fields would have meant approximately 17 million more bushels of corn in Nebraska alone. Over the entire United States a 10 per cent increase would have meant approximately 272 million additional bushels of corn. Such emergency conditions, while less significant, may prevail in some different area each year. It is of utmost importance at present that we recognize these emergencies and give the farmers every support in combatting them.

This talk would not be complete without some reference to the fourth and extremely important phase of this conference -- the commercial phase. There used to be an attitude in some fields that if you shook a commercial man's one hand, his other hand would be feeling the size of your billfold. Fortunately, that stigma on commercial workers is largely in the past, and we see little of it in the agricultural chemical field. This is due to the quality of men which you are and which you employ. The cooperation has been wonderful and thus far our relations together have been that of "Hail fellow well met. We've got a job to do, let's go!" All of us who are engaged in State and Federal research greatly appreciate the generous supplies of costly formulations that have been

sent to us for use in our experiments. We also greatly appreciate your support of this conference. I hope that we are doing our share in the cooperation.

As we view the days ahead, there are a few clouds appearing on the horizon, and there are intermittent flashes of lightning and the resultant thunder. This is not serious for on any fertile soil some rain must fall and is needed for normal growth. But if the storm becomes too serious, men and materials are destroyed and the dawn of a new day, no matter how bright, finds a lot of scattered wreckage. This field of herbicides and weed control is a broad one, gentlemen, and holds a tremendous future for business, for agriculture, for labor, and for the various professions as well as for the average citizen. Mr. L. W. Kephart has estimated that in terms of 2,4-D there is a potential market of 50,000 tons or 100 million pounds of herbicidal material annually. With such a potential there is great need for a soundly administered industry not only for chemicals but for application equipment as well. With a future so bright there should be little reason for cut-throat competition from an unsound industry to become the storm that wrecks the herbicidal field.

The weed man's Utopia would be a farm, a county, a state, a nation, and a world by which or through which he could drive on the way to his favorite fishing hole, look away and see roadsides, fencelines, farmsteads, railroad rights-of-way, and public grounds with weeds under control and planted to cultivated grasses; weedless crops growing in the fields; and the farmer's daughter sunbathing in the front yard instead of digging weeds. Methods are rapidly becoming available by which the weed man's Utopia could, at a price, be realized in a few years, but we all know that it will take years of research, education, regulation, manufacture, distribution of materials, and plain good farming in a sound agriculture and industry before the weeds that are now present can be most efficiently and economically brought under control. But, put 'er there, brother, we can do it!

PANEL DISCUSSION

CONTROL OF HERBACEOUS PERENNIAL WEEDS

H. E. Wood, Leader

DISCUSSION ON SEVERAL WEEDS

By: K. B. Buchholtz - Wisconsin

Scattered observations have now been made on a large number of miscellaneous herbaceous weeds. Detailed studies have been made on only a few. One is poverty weed concerning which a number of abstracts were received from Canadian workers. Poverty weed was eradicated in several instances by using 2,4-D sprays. Most effective results were obtained when ester preparations were applied in mid summer. The amine, amonium and sodium salt preparations were inferior to the esters in all cases where comparisons were made. Infestations on sandy soils appear to have been killed more easily than those on heavy clay soil. Applications of 2 pounds of 2,4-D per acre appeared most suitable.

No cases of eradication of Russian knapweed were reported, even after three treatments in one case. Top growth has been killed consistently by ap-

plying 2 pounds per acre of an ester preparation but regrowth has always occurred.

Gum weed, on the other hand, was killed by all formulations over a wide range of concentrations at all stages of growth.

Ester preparations killed the top growth of bladder campion when applied at 2 and 4 pounds per acre. Sodium and amine salts were less effective in killing top growth. Nearly normal regrowth occurred the year after treatment regardless of the preparation, rate or stage of growth treated.

In one abstract from Ohio it was stated that wild parsnip plants were quite resistant to 2,4-D in the bloom stage. They were deformed but not killed by applications of 4 pounds and less of the butyl ester. Kills were obtained with applications of 4 pounds per acre.

We received some information concerning field horsetail in which it was indicated that one-half pound of either the ester or amine salts consistently killed the top growth of this fern during the summer months. No estimate of root kill were obtained.

In one rather extensive experiment 2,4-D was used in an attempt to eradicate quack grass. Plots were treated four times at 2 week intervals with 10.7 pounds per acre of several ester preparations. The quack grass was reduced to less than 10 per cent of its original stand but after treatment was stopped all plots recovered rapidly.

DISCUSSION ON HOARY CRESS

By: J. W. Zahnley - Kansas

The control of herbaceous perennials is one of the big jobs that research workers in weed control have undertaken. Control as the term is generally used in relation to combatting this class of weeds may be construed to include (1) prevention of the production of viable seed, (2) reduction of stand and vigor to such an extent that spread by vegetative means is greatly inhibited or prevented and (3) the competition with crops is so reduced that it is not reflected in reduction in yield. It seems now that this degree of control is readily accomplished for most species of herbaceous perennials by the proper use of 2,4-D. But we are not satisfied with control alone -- eventual eradication of infested areas should be obtained.

Considerable progress has been made in combatting this class of weeds but there have been many disappointments, particularly in the results on the deep rooted species such as field bindweed, hoary cress and Russian knapweed. Some of the disappointments, perhaps most of them, have been due to the tendency to expect too much. The apparent kill of 100 percent of top growth accompanied by decay of the crown and root to near plow depth gives rise to high hopes that growth will not be resumed. Regrowth within a few months blights these hopes, and a second set of conclusions is drawn, this time with a tendency to underestimate the value of 2,4-D. A selective herbicide that will kill not only the top growth of most of these species but also the root to depths varying from a few inches to two feet gives promise of complete eradication by repeated treatments,

or by use as a supplement to other methods of control such as crop competition and cultivation. The carry-over effect of 2,4-D from one season to the next has been observed in a number of instances, for example, treatment of ironweed in May of one year failed to kill all the top growth that season. When growth started from the crown the following year, the residual effect of the chemical was manifest in elongation of the growing tip and the production of leaves consisting almost altogether of midrib, and the extension of growth of the veins which appeared as spine-like structures projecting as much as an inch beyond the margin of the leaf. Dandelion also sometimes resumes growth in the season following treatment with leaves consisting of nothing more than the midrib. These cases suggest the possibility of a cumulative effect of 2,4-D by repeating the treatment in successive seasons, for certainly the chemical remains in the system of some herbaceous perennials in sufficient quantity to influence growth the next season. There is likewise the possibility of the weed building up resistance as a result of repeated treatments, however, there is no evidence of this in the species that we have worked with. An effort to eradicate a deep rooted perennial may require patience and persistence as well as attention to time of treatment and conditions under which the treatments are made. Eradication or a near approach to it should not be expected in one season.

There is considerable evidence that fall applications are more effective than those made in the spring or summer on the herbaceous perennials that resume growth in late summer or fall after seed bearing and a period of some degree of inactivity or apparent dormancy. This has been reported in connection with the treatments of field bindweed, Russian knapweed and hoary cress in the southern part of the area covered by this conference.

It has been my assignment to assemble and study the results of experiments carried on with 2,4-D on hoary cress in seven locations. Four of these are reported from Canada and include experiments conducted in Manitoba, Alberta and Saskatchewan. Three are from the United States, two of them from Kansas and one from Nebraska. Abstracts of these reports and a brief regional summary are in your hands. A detailed review of these reports is unnecessary in this talk since there will be opportunity for open discussion of the subject from the floor. However, mention of a few outstanding points may be in order.

Superiority of the esters over other forms of 2,4-D for control of hoary cress seems to be conclusive. This opinion seems to hold among workers with other species that are somewhat more tolerant to other forms of the chemical than to the esters.

A word of caution relative to judging results too soon may be in order. Hoary cress treated at the bud stage in the spring may respond slowly to the treatment, and in the southern section dry hot weather may come before there is any recovery. Dormancy in midsummer is natural for hoary cress and if weather conditions are not favorable for recovery there may be little or no regrowth in the fall. In such cases, no evaluation of results of the treatment is possible until spring -- a full year after the application of the chemical. When this condition prevails the work is merely delayed and the treatment should be repeated as soon as growth of the weed permits. On the other hand, if there is sufficient moisture to produce regrowth in the fall, retreatment made in advance of frost usually results in severely weakening

the plants. The evidence now available points to continued weakening of the plants by repeated applications.

Applications at prebud or early bud stage in the spring and at the fall rosette stage seem to be most effective.

Relatively heavy rates of two to four pounds per acre seem to be desirable.

The results submitted in the mimeographed abstracts were obtained under widely varying conditions and are worthy of extensive study and discussion. I shall conclude my remarks in order to allow time for full expression of your interpretations and opinions in this panel discussion.

DISCUSSION ON BINDWEED

By: Lyle A. Derscheid - South Dakota

It has been my privilege to review abstracts of work done on field bindweed with 2,4-D in the area west of the Mississippi river. There are four general trends that I would like to discuss. These four factors are not new, but serve merely as a confirmation of our previous thinking. The four factors that I intend to discuss are the rate of growth and stage of growth as they influence the effect of 2,4-D, a comparison of various formulations and the amount of 2,4-D needed for effective control.

The first and perhaps the most important factor to consider is the close correlation that exists between the effectiveness of control and the soil moisture content. This factor was not reported by all contributors, but those that did were in close agreement. When there was an abundance of soil moisture, which we would assume to be conducive to a rapid rate of growth, 2,4-D was most effective. It is reasonable to believe a frost would also affect the rate of growth. One investigator made spring treatments shortly after a frost; whereas, another made fall treatments shortly after a frost. Both were ineffective.

When soil moisture was abundant, effective control was obtained when treatments were made on full emergence, bud, full bloom, and fall stages of growth. This was not true of instances where treatments were made shortly before or shortly after a frost. Treatments made when bindweed was in the summer dormancy stage of growth were seldom effective. The chemical is most effective or the weeds are most susceptible when the weed is in the budding or blooming stages of growth, provided, of course, that good growing conditions prevail. This may be correlated with the rate of translocation of food and with the root reserves. The root reserves are either on a decline or at a low ebb when the bindweed plants are budding and blooming. The rapid rate of growth is conducive to a rapid translocation of food and water in the plant and this may aid the chemical in reaching the roots where they can do their damage.

One pound of 2,4-D acid per acre was the minimum dosage for most of the experiments. When good growing conditions prevailed there is little difference in the effectiveness of the different formulations when this amount of 2,4-D acid is used. Under adverse growing conditions, the esters were more effective

than the other formulations when the same amount of 2,4-D acid was used. In most of the experiments an old type sodium salt was used. In those that used a monohydrate sodium salt, it appeared to be more effective than in those that used the older type. It is my belief, and I'm speaking from personal experiences, that the more soluble monohydrate sodium salts will prove to be more nearly equal to the other formulations.

Almost all investigators indicated that it does not seem advisable to use more than two pounds of 2,4-D acid per acre. Under favorable growing conditions, one pound of 2,4-D acid in any form was quite effective for bindweed control. Under less favorable conditions one pound or more of 2,4-D acid in an ester form was needed or else more than one pound of 2,4-D in the sodium and amine salt forms was required.

These abstracts were obtained from work done in the states west of the Mississippi River and in two provinces of Canada. I have not checked with Dr. Fuelman to see if this agrees with results from east of the river.

DISCUSSION OF CANADA THISTLE

By: A. L. Bakke - Iowa

Ladies and gentlemen of the Weed Conference. Since we have limited time I'll confine my remarks to some of the experimental work we have done in Northern Iowa. We find that the Canada thistle belongs to the resistant group of plants. It has not been possible to kill the Canada thistle with one application of 2,4-D, no matter how strong or how much 2,4-D was used. Now the weakest point in the physiological history of Canada thistle is, according to our chemical analyses, the early bud stage; we have found less food material in the root system of Canada thistle at that time than any other time. It would be natural then to concentrate our attack at that particular point in the history of the plant. As we are not able to kill the Canada thistle with one application of 2,4-D, that is to make a permanent kill where the tops along with the roots are killed, we can, however, kill the tops; these can be killed by spraying with one to two pounds of 2,4-D. Usually we figure that if we make one treatment at the early bud stage and then make a second treatment sometime in September we are able to reduce the stand of Canada thistle by approximately 70 per cent. The reason for the reduction appears to be this: The 2,4-D is translocated or moved in a vertical direction and does not travel very far in a horizontal direction. When a weed like Canada thistle is sprayed with 2,4-D, the tops are killed. The underground root portion will then produce new shoots, and if we rely on the one application we will find that if we count the shoots appearing later on in the season, we will have a larger number of shoots than we had to start out but they will not be nearly as big. We can then conclude that it is necessary to treat Canada thistle plants further, or give them more than the one application. Usually the best results are obtained by making two spray applications a year. In some of the 2,4-D work, we did in 1945 and continued in 1946 and 1947, in Iowa we found that we had at the end of two years something like a 95 per cent reduction in the original stand. Where we mowed the Canada thistle, and then sprayed in the fall, we had a reduction of 40 to 50 per cent. Where we have continued the 2,4-D two treatments, the following year, the stand has been reduced to as much as 95 per cent. We have

sprayed Canada thistle growing in oats when the oats were in the milk stage and have produced a reduction in the stand of approximately 90 per cent, when the regenerated thistles in the stubble were sprayed the second time during the growing season. The ester formulations have invariably given us better results than the amine or the sodium salts. Thank you.

DISCUSSION ON SOW THISTLE

By: Geo. Knowles - Canada

With reference to the results obtained from the application of 2,4-D on perennial sow thistle all experimenters who reported agreed that no one treatment gave complete eradication of this weed. There was unanimous agreement that better results were obtained from the ester and amine formulations than from the same amounts of sodium salts.

It appears that 1-1/2 pounds of 2,4-D acid per acre are required to produce a complete top kill of perennial sow thistle.

There was some difference of opinion regarding the stage of growth when optimum results are obtained from applying 2,4-D on perennial sow thistles, but the majority favoured application during the rapid growth stage.

One reporter doubted the practicability of controlling this weed by the use of 2,4-D in a grain crop. Further experimentation, however, may prove this conjecture to be incorrect. This method of control would certainly be most desirable.

NOON LUNCHEON - HOTEL KANSAN

Noel Hanson, Chairman

Speaker Introduced by: T. K. Pavlychenko

By: Dr. L. E. Kirk - Director Foods and Agriculture United Nations

Mr. Chairman, Professor Hanson, Professor Pavlychenko and Gentlemen:

I was very pleased to accept the invitation of your president to address the luncheon meeting of this conference, and the reason I am here is very much as Dr. Pavlychenko has said, that I am not unfamiliar with this field of research and I had always made up my mind that whenever I could get a chance I would attend these conferences. But since our university could never afford to send more than one man, of course we always sent Professor Pavlychenko.

I know you are all familiar with FAO, that is the Food Agriculture Organization of United Nations -- I mean that you are familiar with the name and you are familiar with its general objectives. But I find that there is a great deal of mystification and lack of understanding of what the organization is, what it is trying to do and how it is trying to do it.

What I would like to do, if I can, in the short time at my disposal, is to bring FAO down out of the clouds. I would like, if possible, to make it a little more of a reality than it is to most people at the present time, because

this organization is a United Nations enterprise. It is strongly supported by the United States Government, financially and morally. We get an enormous amount of help from the United States Department of Agriculture. I sometimes am surprised at the generosity of the U.S.D.A. in giving us access to the results of their work, giving us advice on research problems, and releasing men when we need them to go on missions and do jobs in other countries. So, I think it is up to every scientist in the United States to make himself familiar with this great international effort, even though you may have your own private doubts as to the ultimate success of the undertaking. Now, just a word to clarify a point as to the relation of FAO to the U.N. As you all know, the U.N has its Assembly, its Security Council, and its Social and Economic Council. These are integral parts of the United National proper. Around the United Nations have been organized a group of what they call Specialized Agencies. They are autonomous bodies with their own budgets, and their own national membership. But they work in close harmony with the United Nations, and to these specialized agencies have been assigned certain large areas of responsibility, -- FAO food and agriculture, WHO, World Health; ITO, World Trade; and so on.

Now, I think perhaps that is sufficient to give you the picture.

Now may I clear up one or two misconceptions about FAO. I have an idea that maybe seventy-five percent of the people confuse FAO with UNRRA, to some extent. They think FAO has something to do with the purchase and distribution of food supplies. Everyone is so familiar with the activities of UNRRA which was a relief organization, that it is only natural, I think, that there should be confusion in this respect. FAO is not a relief organization, does not purchase or distribute food or any other supplies, but it is vitally concerned with the food problem, with starvation and malnutrition in any part of the world, and also with food surplus in any part of the world. It is not a research organization. FAO has no research laboratories, and does not intend to. It is more concerned with interesting the scientists of the world, in their laboratories and in their work, and enlisting their interest in some of the very urgent problems of other peoples, and in coordinating their work in the solution of those problems. And, of course, it is not a political organization, but operates as an international agency on a strictly impartial basis.

What then is the job of FAO? Well, originally it was stated to be and still is, to raise the standard of living of peoples throughout the world. Of course, the spark plug, or the original idea behind FAO, developed out of one of those freedoms of the Atlantic Charter, Freedom from Want. It was President Roosevelt who called a meeting of 44 nations at Hot Springs, during the darkest days of the war, in order to try and implement that freedom. That was the beginning of FAO.

The objective that grew out of that ideal was "to raise the living standards of people throughout the world." I think it was felt that if every internationalism or international cooperation was successful, it would be necessary to do something about the very serious living conditions of one-half the people of the world. And it was thought that if we could have an International Organization concerned all the time about this particular problem, and if that organization could mobilize the scientific information of the Western Nations, that they could perhaps do a lot toward helping these other people raise their standard of living. That was the idea.

Now, they handed this job to FAO -- but they didn't tell FAO how to do it. It is one thing to have an ideal, and a great objective; it is quite another to find ways and means of furthering that objective and implementing it. I will say more about that in a minute. The other thing that was worrying the nations was a carry-over from the thirties when we had food surplus in this country, and did not know what to do with it. Everybody expected that after the war surpluses would develop again. We know that there never has been an over-all surplus of food, and we know that when food surpluses develop it is an indication of mal-adjustment and mal-distribution of food. It is because other people can't buy the food, that they develop. Now, it was thought that FAO as an international organization might do something about that. They might see these surpluses coming and work out ways and means whereby the surplus food could be made available to other countries that need it badly.

It turned out, of course, that we have not had surpluses. As a matter of fact, at the present moment we are in the midst of the greatest food crisis the world has ever seen, -- worse than at any time during the war or since. I needn't go into that picture at all because you have read enough about it in the papers. I will just give you one figure, though, that is this, -- the needs of the world for the next year are about 39,000,000 tons, and there is in sight only about 29,000,000 tons, or 10,000,000 short. And no matter how much food is made available, it will only be sufficient to enable many countries to scrape by, and even then there will be millions of people die. There are going to be millions of people suffer from malnutrition and afterwards die through disease contracted because of malnutrition. There is no doubt about the food crisis. Although we have not had this problem of food surpluses, people still have that worry in the back of their heads. And no wonder, because we still have the dollar shortage to contend with.

The Hot Springs conference was a remarkable meeting. If you read the minutes you will see that it did a wonderful piece of work. The delegates were not Utopian, or too idealistic in their aims. They saw perfectly clearly some of the problems ahead. And they saw this, that to talk about America feeding the world was just nonsense. Or to talk about any of the food producing countries, surplus food producing countries, feeding the rest of the world was nonsense. These food surpluses are extremely important to stave off starvation in times of crisis, and they are extremely important for certain nations that must always import food. But they are just a flea-bite, when it comes to feeding the world. And if the standard of living is ever to be raised permanently in these less developed countries, it will have to be done by the people themselves.

That view was clearly enunciated at the Hot Springs conference. And it's the truth. It is the basic reason why the surplus food producing countries are the greatest supporters of FAO. Although FAO is concerned with increasing food they know that if the standard of living of these less developed countries is ever to be raised, it must be done by the people themselves. The chief means by which the highly developed countries like America, Canada, Great Britain, Australia and so on -- the chief means of helping those other countries is to share with them our great superiority in science, in technology, in information, in modern methods, in our means of doing extension work, and, on request, of course, send our scientists over there and have them analyze certain problems that are too difficult for them to deal with. The disparity between those countries and our country, in educational institutions, in science, in technology, in the modern equipment which we have, is just beyond belief. Look at the

knowledge that you have gained already in this field of weed control while these other countries know nothing about it for all practical purposes.

In trying to accomplish its objectives, and do a job, FAO has two big advantages and I want to point those out to you. And this is the real argument for FAO. It is an organization of fifty-four nations which have banded together and signed a Charter to work with one another in bringing about these results we hope to bring about, -- so that when the secretariat (that is the working part of FAO), sets out to do a job we don't go into another country as a foreign nation. We go into it as a member nation of FAO. We go on request. You see, therefore, we have an entre we couldn't get in any other way. It is a cooperative enterprise and, as a matter of fact, that is the reason for FAO.

The other advantage we have is this -- that most of our work is with scientists and with technologists and with men who are well informed on scientific principles. Scientists are the finest people to work with in the world, because they think internationally. You bring together a group of scientists, as we have done several times, from say eight or ten countries -- the best we can get. We bring them together and sit around a table to discuss a problem. And the last thing in the world those fellows ever think of is that they are different nationalities. They think internationally. Their science is an international thing, as you know.

Through the scientists and technologists and well informed people, therefore, we are able to get an international understanding of what we are trying to do, why we are trying to do it and how we are trying to do it. And these people invariably respond with enthusiasm to that appeal. So we have not had much difficulty in getting very good men to take on a job and go anywhere to do a piece of work.

Now the first thing that FAO did, and I think one of the most important, was to set up a strong statistical department. Unless FAO becomes the best source in the world on the statistics of food production, food distribution and food consumption, it will never become a strong organization. We must proceed on the basis of facts. It is not easy to develop a world source of sound statistical information on agricultural production, distribution, and consumption of food. It is a difficult problem. The International Institute of Rome was the only attempt that I know of that has been tried. FAO has taken over that organization, and it is hoped to make FAO the best source of information on these questions. Now, if it becomes the best source, its recommendations will carry weight with member governments, because it will know more about it than anyone else. We cannot afford to advise member governments on important issues unless we have the facts and that is why, basically, the statistics division, in my opinion, should be particularly strong, and is in a unique position of responsibility. Also, we have several other divisions. These are forestry, fisheries, nutrition, information, and agriculture. It is the agriculture division that I am interested in, primarily. I will just mention a couple of projects that I am personally responsible for, to give you an idea of the kind of things we are working on.

I went to London this summer, in July, and we had an international meeting on infestation control -- control of insects, mites, rodents and fungi in stored grain. Before the meeting, we had made a world survey through a ques-

tionnaire to member governments on their best estimates of food losses due to these pests. We attacked it from all angles and there seems no doubt that at least 10% of the world's production of cereals and cereal products are destroyed annually by these pests. That is more grain and grain products than enters into world trade altogether. You see the enormous importance of that one thing in the matter of saving food. So we are putting forth great efforts to help to instruct FAO member nations about inspecting their warehouses and their ports and their ships, and so on. Not that we can hope to save all of it, or even ten per cent. If we could save 10% of the waste alone, we could save 200,000,000 bushels of this year's crop. And so we are making available to member governments the services of experts, because many of them don't really understand modern methods of fumigation, or residual sprays, or other effective methods of control. If necessary, we can bring their technical men together, and give them two or three weeks training, and tell them how to go about this business.

Another thing that will interest many of you people is our project on genetic stocks. It is surprising how many have asked FAO to do this particular job. And here again we have recently received exceptionally good help from the USDA. What we are trying to do is make a world catalog of genetic stocks; of wheat, oats, barley, flax, rye, peas, beans, cotton, soybeans, tobacco, the whole business, so that plant breeders will know where to write for information. If they want a disease free strain to breed with, we can tell them whether it is available anywhere in the world. I thought, when I started with this job, that it might take a staff of about fifty people to handle that work, but we are putting it on a punch card basis and we can readily handle thousands of varieties and strains; I think there is going to be at least ten thousand or more varieties and strains and genetic stocks of wheat alone. Suppose a plant breeder wants to know if there are any wheats resistant to leaf rust. And suppose there are only five resistant varieties. The cards can be flipped through a machine in a few seconds and those particular varieties picked out and their characteristics printed on a sheet in another minute or two. So we are getting in a position where we can handle the job efficiently. I think it is going to be a matter of great interest to plant breeders and to all of our scientists when we get that thing going. I have just mentioned two projects in my own branch, just to give you an idea of the sort of thing we are trying to do.

This work on weed control that you are doing is of great interest to us, because we know perfectly well that FAO member countries are going to approach us asking for the latest information on the use of growth promoting chemicals. I am glad they have not done that yet, because up until now you are all familiar with the doubts that have been in our minds as to just how far these things can be used safely. The background of research which you men have done in the last four years, and which is now culminating in pretty clear-cut conclusions (although there is lots to be found out yet) is going to be of enormous assistance to us. And don't ever think for a minute that this is only a matter of weed control. These hormone substances are going to have all kinds of applications in other countries for different purposes. We know how vast are the losses of food products caused by weeds. Dr. Hanson this morning gave us some estimate of what could have been produced by use of these chemicals on corn this summer, if it had been applied at the right time.

I have not the slightest doubt that we are going to be able to call on some of you people and get just the help we need. Our soils men went to the agronomy meetings at Cincinnati with a problem in connection with fertilizer,

and the soil scientists set up a committee to help work out the problem. We may find it necessary to ask you, some time in the near future, to appoint a committee and help us to work out some weed control problem. At any rate, we will feel free to ask for help if that help is needed in order to assist somebody else who has not had the facilities for research, and so on, that you have had.

WEDNESDAY AFTERNOON

SECTION I - PANEL DISCUSSION

CONTROL OF WEEDS IN AGRONOMIC CROPS
F. L. Timmons, Chairman
CORN, SORGHUMS, and SOY BEANS
O. C. Lee, Leader

DISCUSSION ON CORN, By: O. C. LEE - Indiana

Here are a few figures we gathered in Indiana this year. Corn was treated with one-fourth pound, one-half pound, one pound, and one and one-half pounds of 2,4-D per acre. Corn at the time of spraying was approximately 12" tall. The spray was applied above the corn so that the 2,4-D went down over the plants as well as between the rows. When the plots were harvested, the checks were found to produce 69.8 bushels, areas treated with one-fourth pound 69.2 bushels, those treated with one-half pound 70.6 bushels, with one pound 66.9 bushels, and where one and one-half pounds were used 65.5 bushels. You will notice that the heavy dosage reduces the yield 4.6 bushels per acre. In these plots where the heavy dosage was applied, several plants were broken by the wind following spraying. The plants were somewhat brittle from the effect of the 2,4-D.

Another experiment designed to study the effect of 2,4-D on corn at different stages of growth was conducted. The corn was sprayed with one pound of 2,4-D, using a sodium salt, when corn was 6", 12", 20", and 30" in height. Yields from plots sprayed at 6" high were 5.8 bushels less than the check, when treated at 12", a 1.3 bushel increase was obtained. A reduction of 5.8 was noted when sprayed at the 20" height, and a 2.7 bushel reduction of yield over checks when sprayed at 30". You will notice that there was not a great deal of difference in yields. It is however, worthy to note that least damage was caused when corn was sprayed at 12" in height.

A question has come up about spraying over the corn and spraying from the side. We did this on 12" and on 30" corn. There was very little difference in yield, if any, when these two methods were applied to small corn, up to 12" in height, but on large corn, 30" in height, yields were reduced 8 bushels per acre from checks when the spray was applied over the top as compared 2.1 bushels when the spray was applied from the side. It therefore appears that danger of damage to corn from 2,4-D sprays can be minimized by applying the spray from the side rather than over the top of the corn. This is especially true when spraying large corn. We also noticed that by this method a more complete weed kill is obtained when material is applied directly to the weeds below the umbrella formed by the corn leaves.

Another interesting experiment was conducted in the northern part of the state. Six plots through a 20-acre field was sprayed with a row crop type sprayer applying one and one-half pounds of 2,4-D per acre. The entire field was cultivated once before spraying when the corn was approximately 6" in height. The spray was applied when the corn was approximately 18" tall. The unsprayed area was cultivated a total of three times while the sprayed area was only cultivated once. A good weed kill was obrained in the sprayed area while several smartweeds, ragweeds, and pigweeds survived three cultivations in the unsprayed area. When the areas were checked for yields the unsprayed area, receiving three cultivations, yielded 70.6 bushels per acre. The sprayed area, receiving one cultivation, yielded 87 bushels per acre, a difference of 10.9 bushels in favor of the sprayed area. It is a question whether this difference in yield is due to the effect of weeds or late cultivation causing damage to corn.

Are there any further questions you would like to ask?

DISCUSSION ON CORN, By: A. L. BAKKE - Iowa

Our experiments in spraying corn in Iowa this last year to control weeds were confined to the early stage of growth when the corn was about 10 inches high. On June 19 at Kanawha, Iowa in the northern part of the state, four long rows of hybrid corn were sprayed with Weed-No-More at the rate of one pint per acre in 100 gallons of water and another four rows with Weed-No-More at the rate of 1/2 pint per acre. The eight rows were cultivated twice during the season, the first and third cultivations were eliminated. The control area was given four cultivations. The yields from 100 stalks of the two sprayed and control areas were taken. They were as follows:

1. Weed-No-More - - - - - 1 pint per acre - - - - - 45.5 lbs.
2. Weed-No-More - - - - - 1/2 pint per acre - - - - - 42.0 lbs.
3. Control -- No treatment -- cultivated - - - - - - - 42.0 lbs.

At time of harvest there was no difference in the number of weeds. From the data submitted it is safe to state that there was no decrease in the yield due to spraying.

On June 28, corn at the same stage of development was sprayed with two pints of Weed-No-More per acre in 100 gallons of water at Crystal Lake, Iowa also in the northern part of the state. Here 1/4 acre was sprayed and cultivated once while the 1/4 acre control was cultivated twice during the season. The yield data were as follows:

Weed-No-More - 2 pints per acre - one cultivation	730 lbs.
Control - Not sprayed - two cultivations	725 lbs.

Here again it is clear that the yield of corn was not reduced by spraying with 2,4-D. It is shown too that corn at the 10 inch stage of development is quite resistant to 2,4-D. From these two sets of experiments it appears possible to eliminate the first cultivation of corn.

Mr. Kenneth Bayne of Sherwin-Williams Company, located at Sioux City, Iowa has sprayed about 2,000 acres of corn this last year. I have asked Mr. Bayne to give us an account of his experiences in spraying corn.

(Mr. Bayne's paper starts on page 28.)

DISCUSSION ON CORN, By: NOEL HANSON - Nebraska

In order to gain additional information regarding the use of 2,4-D on corn several treated fields in eastern Nebraska were observed and results noted. An estimate of 50,000 or more acres of corn in Nebraska were treated with 2,4-D for control of weeds, including cocklebur, sunflower, pigweed, velvetleaf, bindweed, and several other species following wet cultivation conditions in spring. Approximately 1,800 acres of the above figure were treated by airplane, the remainder by various types of ground equipment, much of it built by farmers for mounting on their own tractors. The table attached shows results of the study. Following is a summary of the study including information not in the table:

1. The weed species listed above plus smartweed and the weedy grasses, foxtail and sandbur, were the most serious weeds in eastern Nebraska corn fields in 1947. Cockleburs were especially numerous.

2. Most of the spray equipment used was tractor-mounted with the water supply carried either on the tractor or on a trailer behind. Other units included tractor-trailed sprayers, jeep and truck-mounted sprayers, airplane sprayers, and small auxiliary-type trailer mounted on portable spray units. Most of the spraying was done at low volumes of 5 to 40 gallons per acre over the tops of the corn plants.

3. Although all three type formulations were used the greatest percentage was butyl ester of 2,4-D. Dosages varied from approximately 1/4 to 1/2 pound of either acid equivalent or ester per acre. Some heavier dosages up to one pound per acre were applied, but the heavier dosages were in minority.

4. Application of 2,4-D was made to a wide range of corn hybrids, but from the study no difference in tolerance between hybrids could be determined, although some differences undoubtedly exist.

5. Effect on the corn plants from treatment varied from zero to as much as 10 per cent, but even where plants were partially lodged, brace roots distorted, or root volumes reduced, good ear formation was noted and in most cases fewer barren stalks were found in the treated than untreated areas. Broken

plants were evident in some fields and were apparently due to overdosage. Most distortion of plants was found in fields that had either been treated twice or given dosages of over 1/2 pound originally.

6. Yields in one field were 11 per cent higher than the untreated from one treatment and 49 per cent higher from two treatments. Two other fields showed 44 per cent increases over the untreated from one treatment each. Several fields observed had no untreated areas remaining making a comparison impossible. In one field the untreated area was relatively weed-free and no comparison was logical except on effect on plant morphology.

7. Observations on weed control showed that cockleburs and sunflowers were largely eliminated from the treated areas. Good kills were also obtained on pigweed, velvetleaf, and wild artichoke. Pennsylvania smartweed was reduced with a second spraying in one field, but in most cases was quite tolerant. The foxtails and sandbur were not noticeably affected from foliage spray. There was some indication that treatments at the laying-by stage to some extent prevented germination and development of the grassy weeds later.

8. No case of disappointment with results was encountered among farmers interviewed. Most expressed the opinion that chemical weed control would have a place on their farms each year from now on, not only for weeds in corn, but for fence rows, roadsides, ditchbanks, and other crop spraying as well.

9. From the above study it may logically be concluded that:

   a. 2,4-D has been proved as a valuable supplement to cultivation for control of weeds in corn in Nebraska.

   b. There will be considerable demand for both spray equipment and 2,4-D chemicals in 1948 in Nebraska.

   c. A fairly narrow range of safety in dosages exists between minimum effective dosage for weed control and maximum safe dosage for corn plants. This range appears at this time to lie between 1/4 and 1/2 pound per acre of acetate of the ester formulations, between 1/4 and 3/4 pound per acre of acid equivalent of the triethanolamine salts, and between 1/2 and 1 pound per acre acid equivalent of the sodium salts. This was true under 1947 conditions of weather and soil moisture, but is subject to change in 1948.

d. Practical application of 2,4-D in corn can most easily be applied by tractor-mounted equipment such equipment to be adapted for spraying both in the rows and between the rows and adjustable for height. Wherever possible spraying should be done from the side of the plants and not over the top, except where weeds are as high as the corn.

e. Low volume sprays of from 5 gallons to 25 gallons per acre are acceptable and amount will depend on spraying conditions.

f. For calibration of spraying equipment the following formulas may be used. (At present low volume nozzles are available from the Spraying Systems Company, 4021-23 West Lake Street, Chicago 24, Illinois, or the Monarch Manufacturing Works, Salmon and Westmoreland Streets, Philadelphia, Pennsylvania, or from their distributors.)

$$\text{Forward Speed in miles per hour} = \frac{495 \times \text{Gallons per minute per nozzle}}{\text{Nozzle spacing in feet} \times \text{Gallons per acre}}$$

OR

$$\text{Gallons per acre} = \frac{495 \times \text{Gallons per minute per nozzle}}{\text{Nozzle spacing in feet} \times \text{Forward speed in miles per hour}}$$

DISCUSSION ON CORN, By: C. J. WILLARD - Ohio

Our experiments in Ohio have been somewhat different from those just reported in that we have been spraying corn to see what the effects on corn would be. The weeds have not been a factor. Incidentally, we sprayed a few weeds, but I want to make it definite that they were not a factor in the results. We started out in '45 with some preliminary trials. With the ethyl ester at four pounds to the acre applied just before tasseling we managed to cut the yield of corn from 80 bushels down to two, so it is possible to do considerable damage to corn with 2,4-D. The same number of pounds per acre of sodium salt at the same time in the same way only cut the yield about 12 bushels.

In 1946 we carried out a very extensive series of treatments from 8 inches high on up to and beyond tasseling, using what now seem like excessive doses. They were about the recommended doses at that time -- two and four pounds per acre. In every case at those rates, not to go into them in detail, we found losses in yield.....a third to a half at all stages before tasseling. The greater losses came from esters, but there were very definite and serious losses from the salts and amines as well. There is no question

but that at those rates, we could and did injure corn materially and seriously. Incidentally, at the early dates when we could get at them we took particular pains to spray the growing points. We filled the growing points with the solutions we were using and I could never see that it had any particular effect on the results. There has been a good deal said about that so we took particular pains to fill the curl with dilute solution. While the plants were injured we could never see that that had much to do with it.

In 1947, we put on one small low-volume, low-rate, test, starting with two-tenths of a pound and winding up with one pound of 2,4-D acid as butyl ester per acre. One pound of 2,4-D acid as butyl ester per acre applied at the four to six leaf stage, 20 to 30 inches high, did not reduce the yield although it did visibly damage the plant. The damage was the same as has been mentioned before. Anything above a half pound gave us brittleness, in some cases so great that the stalks break of their own weight, and "onion leaf", that is, abnormal failure of the leaves to open. We did some work with pure lines; we found one pure line which was almost as easily killed as ragweed. Incidentally, New Jersey, in trying out double-cross hybrids, found that one of our Ohio hybrids was somewhat sensitive to 2,4-D, and it contains this line that I have just mentioned.

We used a couple of acres of experiments this year trying to find out something on stimulation of corn by 2,4-D and our net result to date is zero. Of course that doesn't prove that there is no such thing, by any manner of means, but in the tests that we made we were not able to find any stimulation from 2,4-D used in the ways that we used it.

DISCUSSION ON SORGHUMS, By: W. C. ELDER - Oklahoma

Very few reports have been made on the effect of 2,4-D on sorghums. Annual weeds are not as much of a problem in this crop as they are in many other grass crops. The crop is planted late in the season after most weeds have germinated. It is grown in dry sections where cultivation is possible any time. Sorghums sown broadcast make one of our best competitive crops for weeds.

Two grain and two forage sorghums, 8" to 12" high, were treated with 1/2 lb., 1 lb. and 2 lb. of 2,4-D per acre with an ester and salt formulation. The 1/2 lb. treatments did not affect yields with either type of 2,4-D, while 1 lb. treatments lowered yields slightly. The 2 lb. per acre treatment definitely lowered yields in all plots and these plants lodged badly. The ester type lowered yields more than the salt where 1 lb. and 2 lb. per acre was used. All four varieties seemed to be affected alike.

Sorghums fall in about the same class as corn when 2,4-D is applied to the growing plant, but they will not grow as readily as corn when planted in soils treated with 2,4-D.

DISCUSSION ON CORN, By: KENNETH M. BAYNE
(Sherwin-Williams Company)

I was fortunate in having at my disposal this past year a jeep spraying outfit, by means of which I was able to either witness or supervise the spraying of nearly 2,000 acres of corn in the Tri-State area of Nebraska, South Dakota, and Iowa, near the vicinity of Sioux City. Inasmuch as there were over 100,000 acres of total acreage sprayed in this same area I was able to check on other fields as well.

In preparing for the season we tried to keep the following goals in mind:

1. Observe the effect of 2,4-D on corn at various stages of growth.
2. Observe the 2,4-D effect on various weeds at different stages of growth.
3. Promote the use of low gallonage application.
4. Prove that the butyl ester formulation of 2,4-D can be used successfully on corn.
5. Cooperate with various experiment stations in working out recommendations.

As the season progressed there was such a demand for this type of work that the project turned out to be demonstrational rather than an experimental one. Practically all of the work was done on a field basis. Fields were sprayed under a wide variety of conditions.

Weather conditions permitted only one small test on pre-emergence treatment. This was at the rate of .8 pound of butyl ester of 2,4-D per acre, applied 3 days after the corn was planted. The results of this indicated that the first cultivation of corn could be eliminated when conditions were comparable to those present when this test was made.

Work done on corn plants under 3 inches tall indicated that the corn was too vulnerable to 2,4-D at this stage of growth to be sprayed satisfactorily. The next most susceptible stage of corn was found in our work to be in the early tasseling stage. In general, however, we found that corn could be sprayed with satisfactory results at any stage beyond the seedling stage, especially so where there was enough of a weed problem to cause concern.

That is not to say that there was no noticeable effect on the corn plants in all instances. There was definite ratio of a higher percentage of stalks and roots being affected as the 2,4-D dosage was increased. Where there was severe damage to corn as a result of 2,4-D application, the dosage applied was well above what was generally accepted to be an efficient dosage. In other instances what appeared to be considerable damage to corn during the period of the first 2 or 3 weeks after spraying was not later reflected in the final yield.

2,4-D effect on corn showed up in the form of stalk brittleness, curved stalks, malformed brace roots, and either stimulated or depressed fibrous roots. When what was considered to be the most efficient dosage was used an average of 1 to 2% of the corn showed the effect of curved stalks, malformed brace roots, and affected fibrous roots -- never more than 5%. The brittling effect however sometimes affected up to 50% of the corn plants. Various fields sprayed under seemingly comparable conditions showed a considerable variance in the amount of brittleness produced. Rarely did this brittle effect last over 2 weeks. More study is needed to determine whether it is temperature, soil structure or other factors that causes this difference in brittleness.

We realized that this past spring produced an exaggerated weed growth in most corn fields. Ordinarily the weeds in corn fields can be taken care of the fore part of the growing season by the conventional tillage practices. Eventually it will be only a matter of comparing costs to determine which method will be the most economical to the farmer -- controlling weeds by chemical, tillage, or a combination of both. However the later state of growth of corn has always been a problem as far as controlling weeds with existing mechanical equipment is concerned. Many weeds germinate and mature after the last cultivation. With this in mind we fashioned an eight row sprayer on a corn detasseler, which enabled us to continue our spraying operations, and determine the practicability of spraying this late in the season. We continued to spray until the kernel became hard in the ear. Our results can be summarized by noting that every farmer considered the spraying operation a paying proposition. The later the season the less the results were reflected in increased yields. Results instead were measured in the reduced viability of weed seeds, and easier harvesting operations.

No attempt was made to keep any of the spray off of the corn plants in any of our spraying operations. This would not have been possible anyway as the weeds in most all instances were as tall or taller than the corn. It also simplified our boom construction and operation.

To sum up our observations on stage of growth of spraying in corn:

Corn was sprayed at all stages of growth.

Results indicated that the type and intensity of weed infestation should govern the optimum time to spray corn -- rather than the stage of growth of the corn itself. In other words we think it would be a good idea to suggest that spraying operation begin before the weeds start to crowd or shade the crop, rather than worry about the exact stage of corn development.

As far as the weeds are concerned, of course the earlier the annual susceptible weeds are sprayed the easier they are to kill. However we did spray cocklebur, for instance, as late as the period of bur formation -- while they were still green and growing. The seeds as a result of this spraying were chaffy and non-viable. Rank growths of other susceptible annual weeds approaching maturity also failed to produce seed when sprayed with a relatively low dosage of the ester formulation. This indicated that the spraying season can be extended quite a good deal if necessary.

Susceptible perennial weeds were also controlled effectively in corn. These included field bindweed, leafy spurge, and Canada thistle. A dosage of ester was used that would kill these perennials back sufficiently to allow the crop to mature normally, and low enough not to injure the corn plants. Our most effective results were obtained by spraying as soon as the perennials had recovered sufficiently from the third cultivation. More work needs to be done experimentally to prove this great potentiality for 2,4-D -- that is -- low cost control of perennials in corn and other resistant or semi-resistant crops.

Low gallonage. We used 4 to 5 gallons of water per acre at all times with our jeep sprayer. With our converted corn detasseler we used 8 gallons. This was because the ranker and denser growth of both weeds and corn required more material for adequate coverage. In only the very tallest and leafiest corn did we fail to get complete coverage of the weeds. There were some instances where as much as 2% of the susceptible weeds did not get enough 2,4-D on them to constitute a lethal dosage. A desirable feature of our boom construction on this converted sprayer consisted of two - 18 inch vertical extensions, 15 inches apart, between each row. When the weed were as high or higher than the corn we could raise the entire boom section high enough for adequate coverage. When the weeds were smaller than the corn, the boom was lowered so that the extensions extended down past the upper whorl of corn leaves, allowing the maximum amount of spray material to reach the weeds. Under no condition was there an indication that a higher gallonage would have been more efficient.

There was an indication that there was less of a 2,4-D effect upon the corn when the low gallonage technique was used, when comparing results of corn fields which had been sprayed with high gallonage. This may be as a result of less 2,4-D material collecting in the nodes and on top of the growing point of the plant.

Adequate equipment is necessary for low gallonage application. Our outfits were equipped with rated precision nozzles, number 650066, spaced 20 inches apart on the boom. Each nozzle was equipped with a 200 mesh, monel metal strainer. Ahead of the pumping unit was still another 200 mesh strainer. A sensitive by-pass valve, and pressure gauge were found to be necessary features. Any pressure desired could be held constant, permitting accurate output. Our season's work indicated to us that with careful handling of adequate equipment, low gallonage technique of application is entirely satisfactory.

Our work with the butyl ester formulation indicated that it is not at all dangerous to use on corn when the correct dosage is applied. Our experience has been that any 2,4-D formulation must be used with certain limitations when applied on crops. The main limitation is dosage, and when the correct amount of 2,4-D is applied a good deal of success may be expected. The dosages of butyl ester that we used ranged between one-quarter and one-half pound of butyl ester per acre. About one-third of a pound in ester form was the best all around dosage to use for susceptible annual weeds in corn. Using 40% Weed-No-More as an example, this amounts to about 4/5 pint per acre, or one gallon to ten acres.

In summarizing our results, it was not unusual to find instances of 45% increase in yield of sprayed portion of a field over the unsprayed. This amounted to as much as 100% in some cases where the weeds would have otherwise

meant a total loss. There were a lot of happy farmers. We are confident that if care is taken by the various chemical companies, and the official institutions to promote the education of how best to apply this chemical known as 2,4-D, there will be more and more happy farmers each year.

SMALL GRAINS AND FLAX
L. M. Stahler, Leader

SOME OF THE EFFECTS OF 2,4-D ON NINE OATS VARIETIES (1)
By: Lyle Derscheid - South Dakota

Nine varieties of oats, Tama, Clinton, Bonda, Mindo, Marian, Vikota, Richland, Trojan, and Brunker were compared in triplicate for their responses to 2,4-D. Treatments of one pound of 2,4-D acid equivalent to the acre of a butyl ester, a triethanol amine, and a monohydrate sodium salt were compared with "no treatment" at four stages of growth. The four stages of growth were (1) seedling, (2) fully tillered, (3) shooting, and (4) fully headed. Each plot consisted of a drill strip four feet (8 rows)wide that was twelve feet long. The center two feet (4) rows) were harvested by hand out of the middle eight feet of the plot. Yields were calculated and germination tests made. These data were analyzed statistically.

The ester is slightly more severe on oats as it produced an "onion top" effect on all varieties when treatments were made at the "seedling" stage of growth. The leaves were curled inward, tightly, from both edges. This abnormality was most apparent one week after treatment but was still present, to a lesser degree, at harvest time. Two or more panicles were produced from many individual sheaths. No other abnormalities were observed in the entire experiment.

An analysis of variance on yields produced an "F" value that was not significant, indicating that significant changes in yield of these nine oat varieties was not caused by any of the three formulations of 2,4-D used. A significant "F" value for the interaction "dates of treatment x treatment" was significant, however. The calculation of a minimum level of significance as shown in the accompanying table indicates that the reasons for this significant "F" value are that the mean yield obtained from plots treated the sodium salt in the "seedling" stage are significantly higher at the 5 percent point than the mean yield from the untreated plots of the same date of treatment; and that the yield from plots treated with the ester at the "fully tillered" stage are significantly lower, at the 5 percent point, than the untreated plots of the same date of treatment. These facts are further substantiated by the fact that no significant difference exists among the untreated plots. The writer is at a loss to explain the reason for these significant differences.

Germination tests reveal that the viability of these nine oats varieties was not depressed by the use of any of the three formulations of 2,4-D.

As was pointed out above, an "onion top" effect was produced when treated at the "seedling" stage of growth with the ester. It has also been pointed out

that significant differences in yield were obtained for different formulations at different dates. An analysis of variance on yields for "dates of treatment", however, produced an "F" value that is not significant, indicating that significant changes in yields of these nine oat varieties were not caused by treatment with 2,4-D at these four stages of growth.

Germination tests reveal that the viability of these nine oat varieties was not affected by treatment with 2,4-D at any of these stages of growth.

No varietal differences were noted in the field, and an analysis of the data indicates that a differential response in yields of these nine varieties to the treatments or to dates of treatment was not obtained. Germination differentials, also, were not obtained.

On the basis of this experiment, it would appear that when one pound of 2,4-D acid equivalent per acre is needed to give satisfactory weed control, that the ester is slightly more injurious than other formulations. It would also indicate that any of these nine varieties could safely be sprayed at any of these stages of growth. In other experiments, however, a marked reduction in yield has been obtained when oats was sprayed at the time that panicles were emerging from the boot.

The average yields of nine varieties of oats in bushels per acre when not treated and when treated with three formulations of 2,4-D at four stages of growth, on the Scotland Weed Research Farm.

Dates of treatment**	Treatments*			
	Ester	Amine	Sodium	Untreated
Seedling	44.6	48.2	54.0	46.4
Tillered	41.8	45.9	44.0	49.1
Boot	45.7	48.7	50.3	46.6
Bloom	48.1	47.3	50.2	51.4

* Least significant difference is 7.5 at 5% level and 11.3 at 1% level

** Least significant difference is 12.9 at 5% level

(1) Experiment conducted cooperatively by L. M. Stahler, Agronomist, Bureau of Plant Industry, Soils and Agricultural Engineering; and Lyle A. Derscheid, Assistant Agronomist, South Dakota Agricultural Experiment Station.

SOME OF THE EFFECTS OF 2,4-D ON EIGHT BARLEY VARIETIES (1)

By: Lyle Derscheid - South Dakota

Eight varieties of barley, Plains, Feebar, Odessa, Spartan, Kindred, Tregal, Wisc. #38 and Manchuria were compared for their responses to 2,4-D. Treatments of one pound of 2,4-D acid equivalent to the acre of a butyl ester, a triethanol amine, and monohydrate sodium salt were compared with "no treatment" at four stages of growth. The four stages of growth were (1) seedling, (2) fully tillered, (3) shooting, and (4) fully headed. Each plot consisted of a drill strip four feet (8 rows) wide and twelve feet long. The middle two feet (4 rows) for a distance of eight feet in the middle of the plot were harvested by hand; yields were calculated and germination tests made.

The butyl ester was the most severe of the three formulations used. All plants that were sprayed in the "seedling stage" produced abnormal heads. These heads produced seed, but did not emerge from the sheath normally. The collar of the sheath appeared to be restricted and would not allow the heads to pass through. The peduncle elongated normally and pulled the heads out backwards; the awns, however, were held for some time in the collar of the sheath. The force exerted by the elongating peduncle finally pulled the awns free, but the awns remained bent at an angle. Approximately 80 percent of the heads on plots treated with the ester were affected in this manner; whereas, only 60 percent were affected on the amine treated plots and 40 percent on the sodium salt treated plots. All varieties lodged to some extent when sprayed in the "shooting" with the ester formulation.

An analysis of variance produced an "F" value for "treatments" that is significant at the 5 percent level. The calculation of a minimum level of significance, as is shown in the table at the end of the report, reveals that the mean yield of all ester treated plots is significantly lower at 5 percent level than the mean yield of plots treated with the amine, or treated with the sodium salt or not treated at all. The ester did not decrease the yield when applied at the "fully tillered" stage, however.

The viability has not been impaired by any formulation.

As has been pointed out above, all three formulations caused the production of abnormal heads when sprayed in the "seedling stage" and that the ester caused lodging when the treatment was made on grain in the "shooting" stage. These were the only abnormalities observed at these stages of growth, and there were no abnormalities observed when the treatments were made at the "fully tillered" and "fully headed" stages of growth.

Analysis of variance on yields produced an "F" value that is significant at the 1 percent point, and the calculation of a minimum level of significance revealed that the mean yield of plots treated when "fully tillered" was significantly higher at the 1 percent point than the mean yield of plots treated at any other stage of growth. This is also shown in the table at the end of this report.

The viability of the first six varieties listed above has not been depressed by spraying with 2,4-D at any stage of growth.

The only field observation that was made with respect to varietal differences was made when the ester formulation was used in the "shooting" stage of growth. Odessa was caused to lodge very badly and many of the plants broke off at the lower nodes.

An analysis of variance indicates that a differential response in yields of these eight varieties to different formulations was not obtained. Likewise, a varietal response to treatment at these four stages of growth was not established. It is possible, however, that if harvesting had been done mechanically, that some grain would have been lost from the lodged plots that were sprayed in the "shooting" stage with the ester and that a differential in varieties might have been obtained. It is almost certain that more of the grain from Odessa would have been lost by a mechanical harvester.

All of the varieties germinated close to 90 percent for each treatment at each stage of growth, so there appears to be no differential response with respect to viability.

On the basis of this experiment, it would appear that if one pound of 2,4-D acid is needed per acre to give satisfactory weed control, the best time to spray any of these eight varieties of barley would be after it is fully tillered and before it reaches the boot stage of growth. It would also appear, that it is somewhat "risky" to use an ester formulation, although the ester did not depress yields or germination at this stage of growth.

The average yields of eight varieties of barley in bushels per acre when treated with three formulations of 2,4-D at four stages of growth on the Scotland Weed Research Farm.

Dates of Treatment	Treatments				
	Ester	Amine	Sodium	Untreated	Average*
Seedling	26.5	25.6	31.2	31.8	28.8
Tillered	31.8	35.8	35.9	31.9	34.1
Shooting	22.5	31.4	30.1	30.2	28.5
Headed	24.8	33.5	28.9	28.6	28.9
Average**	26.4	31.5	31.5	30.6	

* Least significant difference is 2.4 at 5% level and 4.2 at 1% level

** Least significant difference is 3.5 at 5% level and 6.4 at 1% level

(1) Experiment conducted cooperatively by L. M. Stahler, Agronomist, Bureau of Plant Industry, Soils and Agricultural Engineering, and Lyle A. Derscheid, Assistant Agronomist, South Dakota Agricultural Experiment Station.

RESPONSE OF KOTO FLAX TO APPLICATIONS OF 2,4-D (1)

By: R. S. Dunham - Minnesota

The experiment which I am about to present consisted of applications of sodium salt, the amine salt, and the ester of 2,4-D on Koto flax at rates of 4, 12, and 24 oz. (acid equivalent) per acre and at 4 stages of growth; i.e. 2 inches, pre-bud, late bud, and full bloom. The crop was sown in rows and kept weeded by hand so that the weed factor is removed from consideration. Koto was used because it is known to be relatively tolerant of 2,4-D. An 8-oz. rate and a 6-inch stage were not included because they were part of a separate trial. The extreme rate of 24 oz. and the applications at late stages of plant development were included to determine any possible effect on germination, oil percent, and iodine number and especially genetic constitution of the seed produced. The plots were replicated 4 times, the trial was carried at University Farm on silt loam soil underlaid with gravel and at Waseca on heavy clay loam, and a preliminary trial was made in 1946.

The fact that the results of these three trials are in general agreement gives greater substantiation to the following conclusions than would ordinarily be the case from a 2-year trial.

Koto flax, sprayed at the 2-inch stage with 4 oz., was not reduced in yield of seed or straw by any of the formulations and the viability of seeds from these plants was not adversely affected. At the same stage 12-oz. applications of sodium and amine did not appear injurious but the ester reduced yields although the amount of reduction was not statistically significant. Germination was not affected by any of the treatments. All formulations appeared injurious at 24 oz., the ester showing the severest effect on yields and germination. At pre-bud, which represents the latest vegetative stage of the plant, the ester was injurious at 4 oz. and the amine at 12 oz. with sodium showing a tendency toward injury at 12 and 24 oz.

The later applications were made primarily for genetic effect but it is interesting to note that treatment at full bloom was almost disastrous to seed yields but did not affect straw yields importantly.

With a crop as genetically pure as certified Koto flax it is possible to compare formulations with more reliability than when they are tested on mixed populations such as is generally found in weeds. In this trial where rates are based on equivalent weights of the acid, there were no differences between formulations when the dosage was considerably less than the maximum tolerance of the variety and applied when the flax was from 2 to 8 inches tall. When the dosage approached the maximum tolerance or when the time of application was later than the optimum stage of growth, the crop was injured most easily by the ester and least readily by the sodium salt. The amine was in an intermediate position.

Although yield is the common measure of crop response, the quality has an important bearing on its industrial value. Oil percentages and iodine numbers on Mr. Tandon's variety trial have been furnished by Mr. G. H. Heggeness of the division of Plant Pathology and Botany. The figures conclusively indicate that these factors should be considered in any study of 2,4-D on flax. From these data we may conclude that the oil percentage of some varieties is seriously reduced by even the 4-oz. application while others are unaffected.

At 4 oz. the ester reduced oil in 6 out of 7 varieties, indicating that this dosage is too strong. Also, the ester at this rate lowered the iodine number of all 7 varieties by an average of 7.4. The sodium salt lowered 4 out of the 7 by an average of 5 and the amine salt reduced only Minerva. Taking into consideration the factors of yield, oil percentage, and iodine number and comparing the formulations on an acid equivalent basis, the amine appears the least injurious to the largest number of varieties.

(1) Paper No. 614 of the Miscellaneous Journal Series, Minnesota Agricultural Experiment Station.

RESPONSE OF FLAX VARIETIES TO 2,4-D (1)

By: T. K. Tandon - Minnesota

This study was designed to determine if there is any differential response between 7 commonly grown varieties of flax to the applications of sodium salt, the amine salt, and ester of 2,4-D at the rates of 4, 8, and 16 oz. acid equivalent per acre. The varieties tried were Crystal, Dakota, Koto, Minerva, Redwing, Sheyenne, and B5128. There were 4 replications and the layout was split plot with a total number of 336 plots.

A single plot consisted of three 18-foot rows, of which a 16-foot length of the central row was harvested for yield of grain and straw. The rows were 1 foot apart and the weeds were kept under complete check by hoeing. The herbicides were sprayed when seedlings were 5"-8" tall. This stage for spraying was chosen as it was considered that normally a control of weeds at this stage of crop will be most desirable.

Data collected consisted of growth rate as represented by fortnightly height measurements in each plot, blooming and maturity time, degree and percentage lodging, and the yield of grain and straw. Germination tests and determination of oil percentage and iodine values are in progress.

The analysis of variance for the yields of grain reveals significant F values for herbicides, rates, varieties, and for interaction between varieties and rates. When the reaction of individual varieties to different rates was tested, Crystal was found to be most susceptible and Redwing most tolerant; so much so that even with a 16 oz. application the yield in Redwing was not significantly different from check. Koto and Sheyenne also showed relative tolerance to 2,4-D and B5128 and Minerva were in the susceptible group. To some extent the tolerance of Dakota is similar to Koto and Sheyenne. Even at 4 oz. Crystal and B5128 showed a reduction in yield; the remaining 5 varieties showed no significant depression in yield.

(1) Paper No. 615 of the Miscellaneous Journal Series, Minnesota Agricultural Experiment Station.

THE EFFECT OF 2,4-D ON WHEAT

By: E. A. Helgeson - North Dakota

The first test that I want to report on is on the dates of application, or rather the stages of plant development as they are affected by three formulations of 2 4-D. We used Mida wheat, a commonly-grown spring wheat in our area as a test plant. We used an ester, an amine, and a sodium salt, all of which were applied at a pound to the acre and with a comparable amount of water in weed-free grain. We cultivated the grain to get rid of the weeds. Our results were as follows: In general, plants sprayed with any of the three formulations assumed a somewhat chloritic appearance for a period of three to five days after spraying; this condition was not so apparent in the plots treated with the sodium salt as it was in those plots treated with amine and ester. There was a complete recovery and normal appearance, however, at the end of this period. In the case of the amine and ester formulations applied at the full tiller, and boot stages, it became apparent at the end of a week's time that there had been a marked retardation in the growth of the plants. Observation from this point on as well as plant height measurements showed that the plants in the ester and amine plots never did attain the height of the plants in the sodium test and check plots. Lodging occurred upon application of any of the three formulations used at the bloom and soft dough stages. There was only a slight difference in the yield between the check and the sodium plot in all stages. The amine and the ester formulations showed a general reduction in yield as compared to the check and sodium plots of from .3 to 2.5% at all stages.

The outstanding difference in yield appeared to be in the use of 2,4-D ester in the boot stage. Here the yield was reduced approximately 65%. In no plots did any abnormal heads appear. Culm counts on all plots showed an overall uniform stand as well as a uniform number of tillers per plant. Comparison of test weights showed no significant difference at any stage or with any formulation. In only one instance, that of the ester formulation, applied at the boot stage, was there a significant reduction in the germination of the resulting seed. As compared with the check lot a reduction of 11% was shown whereas a comparison with all plots of this particular stage treatment showed a reduction of 7%. There was a significant rise in protein content in the grain from the amine and ester plots in the tiller stage as compared with the check, while a significant rise was also noted in all treatments in the boot and bloom stages. In the tiller and boot stages, the ester treatment yielded the highest protein, while in the bloom stage, the amine was high. In general such increases did not exceed 1%. We also ran loaf volume determination since this is a bread wheat and proteins are important and these proteins have a decided effect on the loaf volume. Our Cereal Technology Department ran the loaf volume determinations. The loaf volume was quite variable, there being a general reduction in the boot and soft dough stages while the bloom stage compared favorably with the check. The tiller stage ester and amine treatments showed a significant increase in loaf volume.

My next report is on the standardized test for varietal differences in the reactions of spring wheat to three formulations of 2,4-D. Again the same formulations, the ester, the amine and the sodium salt were used at a pound per acre and applied in 80 gallons of water per acre at the full tiller stage. The varieties used were some common bread wheats generally used up in our area, namely, Thatcher, Mida, Regent, Rival and Pilot and two macroni wheats, Mindum

and Carlton. Again we notice thechlorotic effect on plants which generally was overcome later. In measurements of plant height the check and sodium plots were approximately the same whereas the amine and ester plots showed a 10% average reduction for the macroni and a 6% reduction for the hard red wheats. No single variety showed any outstanding differences as to height. The check plots and those plots treated with sodium salt were comparable in yield in all varieties. Those plots treated with amine and ester showed a general decrease in yield in all varieties. I might say again that the decreases were very small, and it is a question whether they are significant or not. Only one of these varieties, Regent, showed heads with abnormal glumes but the percent of abnormality was very small. The comparison of test weights show no significant reduction due to the different treatments within a single variety. In germination tests on grain produced from these plots only two varieties of hard red wheat showed significant differences, namely Mida and Thatcher. In these varieties there apparently was a stimulating effect due to 2,4-D application; the three treated plots of Mida showed an average increase of 8% over the check plots while the treated plots of Thatcher showed an average increase of 12% over the check. There were no significant differences within or between the macroni varieties. A significant rise in protein content was noted in the grains from the ester plots of Thatcher, Pilot, Regent and Mindum varieties while a similar rise in the protein content was noted in the amine plots of Mida, Regent and Thatcher. There was a significant reduction of protein content in the Carlton sodium and amine treatment, as compared with the check. Loaf volume results were quite variable; generally there was no indication of reduction as a result of chemical treatment.

USE OF 2,4-D IN WHEAT

By: Dayton Klingman - Wyoming

Dr. Stahler suggested that our discussion answer six points. From the tests at Laramie, I cannot answer all of these.

1. Comparative efficiency or dangers of formulations tested. We are cooperating in the uniform experiment No. 1 in which five varieties of spring wheat were sprayed with the sodium salt, Butyl ester, and alkanolaimne. Materials were applied at a rate of one pound per acre in 40 gallons of spray material per acre.

TABLE I

SPRING WHEAT VARIETIES (WEED FREE) SPRAYED WITH 2,4-D
Sprayed June 30, 1947 (Full tiller to early joint stage) with 1 lb/acre 2,4-D in 40 gal/acre (30-35 (P.S.I.). Temp. 64° F., Slight breeze.

Treatment	Ave. Bu. Per Acre	Test Wt		Ave. yield of all Varieties with each material
Check (No Treatment)				
Thatcher	61.9	57.4)		52.8
Regent	50.6	58.5)	--56.8	
Mida	47.8	58.0)		
Pilot	56.0	53.4)		
Mindum	47.7	46.6		
Sodium Salt				
Thatcher	59.2	57.6)		
Regent	59.3	58.2)	--56.7	
Mida	54.4	58.0)		54.0
Pilot	46.2	53.1)		
Mindum	50.9	54.9		
Butyl Ester				
Thatcher	49.6	54.8)		
Regent	54.3	56.2)	--55.0	
Mida	46.7	56.0)		49.1
Pilot	46.9	53.1)		
Mindum	48.2	51.9		
Alkanolamine				
Thatcher	47.5	56.5)		
Regent	48.2	57.0)		
Mida	50.3	57.1)	--56.0	46.9
Pilot	49.5	53.5)		
Mindum	42.5	49.0		
Standard error of the mean difference	4.8			2.2

°Difference between yields of materials exceeds 1% level of significance.
Difference between yields of varieties exceeds 5% level of significance.
Varieties x materials interaction not significant.

The yield data for this experiment is shown in the first Table. The difference between average yields for materials exceeds the 1% level of significance. Comparing the average yields for each material with the check, the sodium salt exceeds the check 1.2 bu. / acre, the Butyl ester yielded 3.7 bu. less than the check, and the alkanolamine gave the lowest yields with 5.9 bu. / acre less than the check. The least difference for significance (5% level) is 4.4 bu. / acre.

While there is some differential response of varieties to the various formulations the varieties x materials interaction is not statistically significant.

2. Maximum rate of application that precludes damage to the crop.

One of those which I can't answer. All treatments of 1 pound or more except the sodium salt reported above) at all stages of growth have given reductions in yield (most of the reductions, however, were not significant statistically). Compensating effect of weed control should be recognized in making definite answer to this one.

3. Mimimum rate of application to eliminate weeds in crop. Again, answer is not available. In Wyoming we are most interested, at present, in controlling creeping perennials while getting a partial crop of grain. Higher rates are probably necessary for many of the creeping perennials than for certain annuals.

4. Differences in susceptibility of crop at various growth stages. I reported my results for the 1946 season in a note in the American Society of Agronomy (the 1947 test is not reliable because of various conditions beyond control). In that test the Pilot spring wheat was treated at three stages of growth, with 1, 2, and 3 pounds of 2,4-D per acre.

TABLE II

Germination of Pilot Spring Wheat Which Was Sprayed While Growing, As Indicated Below

1946

Stage of Growth at Time of Spraying	Pounds 2,4-D Per Acre	Average Per Cent Germination: Ave. Germination	Ave. of the 1 and 3 pound rates
Check	No treatment	96.4	96.4
4 - 8 in. high early jointing	1	95.6	
	2	95.5	
	3	93.9	94.7
12 in. high, early boot stage	1	94.5	
	2	91.5	
	3	93.4	93.9
Just heading to heading	1	94.8	
	3	92.2	93.5
Standard error of the mean difference		1.2	

When planted in the field, no observable effect upon stand or upon plant appearance.
Abnormal spikelets (sprayed prejoint) gave normal appearing plants when planted in field.

Spraying in the early boot stage significantly depressed yields. Treating in this stage caused a good deal of sterility, especially in the 2 and 3 pound rates. Plots treated this year (a little later in the boot stage) with 1 pound per acre did not give sterility to any extent. Only one other treatment significantly depressed yields in 1946, that treated with 3 pounds 2,4-D in the early jointing stage. Other yields were all depressed somewhat. You may be interested in how seed from the 1946 test germinated. As you can see from Table II, seed from the treated plots gave a slightly lower germination than that of the check. While differences in percentage germination is significant statistically, it is doubtful if the differences observed are economically significant. Generally seed germinating better than 90% is acceptable to growers. When seed

Plot sizes ranged from 3300 sq. ft. to 2.4 acres. The treatments were made at the rates of 4, 6 and 8 pints per acre with the boom sprayer using 80 gallons of water per acre. The principal weeds in the crops treated were wild mustard Sinapis arvensis, stinkweed Thlaspi arvense, Russian thistle Salsola kali, lamb's quarters Chenopodium album, wild buckwheat Polygonum colvolvulus and hare's ear mustard Conringia orientalis.

Results: Seedlings (4 to 12 leaf stage) of the wild mustard, stinkweed, and Russian thistle were effectively controlled. Hare's ear mustard and lamb's quarters of the same age were seriously injured but had a tendency to recover. Wild buckwheat generally escaped injury from lighter applications (4 pts.) but was set back by stronger doses (6 - 8 pts.).

Unlike 2,4-D, Sinox if applied at the above rates and at temperatures below 80° F had no other effect on crops than slight leaf burning. This generally, had a stimulating rather than harmful effect on yield. The chemical was most effective where the soil was heavy, the stand of crop uniform, the ground moisture before the treatment plentiful and the growing conditions after the treatment favorable. Otherwise, the treated plots were frequently reinfested and the benefits from the initial destruction of weeds considerable reduced or totally lost.

Under very favorable soil and moisture conditions at Regina the increases in yield were from 8 to 41 bushels per acre over the controls. Under moderately dry conditions at Saskatoon the increases ranged from 3 to 16 bushels per acre and under very dry conditions at Cavell and Young the increases fluctuated between 1 to 2 bushels per acre. The weeds were controlled from 72 to 100 percent at Regina, 65 to 95 at Saskatoon and from 47 to 97 at Cavell and Young.

EFFECT OF 2,4-DICHLOROPHENOXYACETIC ACID UPON ANNUAL WEEDS AND GRAIN YIELDS

The ester, amine and sodium salt groups of 2,4-D were tested in the dry prairie regions of Saskatchewan to control annual weeds in grain crops. Heavy clay, heavy clay loam, silt loam and sandy loam soils were included in widely separated districts. The chemicals were used at the rates of 4, 8, 12, 16 ounces of the acid equivalent in 10 gallons of water per acre and applied from the boom type sprayer at temperatures of 60 to 78° F with weeds in a pre-bud stage. The principal weeds were: at Regina, wild mustard; at Saskatoon, stinkweed, wild mustard and Russian thistle; at Cavell, stinkweed, Russian thistle and hare's ear mustard; at Young, wild mustard, stinkweed and cow cockle. Plots were 3300 sq. ft. in size and the data mentioned herein are averages of 8 randomized square yard samples.

Results: The weeds susceptible to 2,4-D were controlled 90 to 100 percent by esters, 78 to 100 by amine salts and 63 to 88 by sodium salts. The kinds of chemicals and the stages of weed growth were more important than the rates used. Grain yields were significantly increased in most plots. Commercial grades were not affected. Occasional deformations occurred on heads and leaves, particularly of young tillers (lax or club spikes and 3-4 bladed leaves). These occurred more frequently in crops treated early (3-4 inches high) and seldom in those more advanced (immediately previous to heading). All annual weeds developed a steadily increasing resistance from the flowering to maturity. The data

from this work may be given as follows: All chemicals gave consistant increases in yield under favorable moisture and soil conditions at Regina irrespective of the rates applied (4 to 16 ounces per acre). These ranged, in the case of esters (wheat) from 4 to 8 bu/ac; amines 4 to 9; sodium salts 4 to 5. Under moderately dry conditions at Saskatoon, ester gave increases 2 to 5 bu/ac; amine 5 to 7; sodium salt 0 to 7. Under very dry conditions at Cavell, ester 1 to 6 bu/ac; amine 0 to 3; and sodium salt 2 to 3. At Young, ester (barley) -1 to plus 7; amine -1 to plus 6; and sodium salt 4 to 14.

HERBICIDAL POSSIBILITIES OF 2,4-DICHLOROPHENOXYACETIC ACID FOR FLAX

Extensive tests with various 2,4-D dusts on flax were made at Saskatoon in 1947. The soil was a heavy clay loam. The spring was dry, cold and late and the summer dry and cool. The principal weeds were: stinkweed, Russian thistle, wild mustard, tumble weed, lamb's quarters, and red root pigweed Amaranthus retroflexus. Plots were 20 by 140 ft. in size. The following chemicals were used as dusts at the rate of 6 ounces of the acid equivalent per acre dispersed by the cotton duster: 5 percent butyl, methyl and isopropyl esters, 5 percent triethanolamine, 5 and 3 percent sodium salt, 5 percent free acid and 5 percent Killo-weed (free acid). At the time of treatment the weeds were rank and in the bud or flowering stage. Their density was from 700 to 1100 plants to the sq. yd. The flax was very patchy, with the plants small but healthy, and it offered an excellent material for studying resistance of the crop to the chemicals, but was unsatisfactory for yield determinations.

Results: The crop successfully resisted all the chemicals, particularly sodium salts, and produced good bolls with apparently normal seed. Isopropyl ester alone caused slight curling of the flax stems but they soon recovered. The effect (percent kill) of various chemicals on different weeds is given in the following records, which represent averages of eight sq. yd. sample counts taken from each treatment:

	Butyl	Methyl	Isopropyl	Amine	Na. Salts		Free Acids	
	Esters				5%	3%	5%	3%
Wild mustard	100	100	100	91	69	28	93	100
Stinkweed	98	96	100	82	49	13	80	94
Lamb's quarters	79	77	89	70	19	0	83	91
Russian thistle (blooming stage)	35	36	41	10	0	0	38	40
Red root pigweed	21	23	26	18	5	0	18	14
Tumble weed	12	10	21	8	0	0	9	10
Flax	0	0	0 (slight curling)	0	0	0	0	0

2,4-D ON SMALL GRAINS AND FLAX

By: H. E. Woods - Manitoba

In the Prairie Provinces of Canada in 1947, about half a million acres of wheat, oats, barley (and a very limited acreage of flax) were treated, in the main successfully, with 2,4-D. The larger part of the chemical was applied as a spray with ground operated machines equipped with low volume nozzles. A considerable number of turbine machines were used also to apply spray. Some six thousand acres were aeroplane sprayed with 2,4-D in oil solution. Dusting was mostly by ground machines -- solid boom and adapted row crop dusters; just under twenty thousand acres were helicopter dusted.

Very satisfactory weed control was obtained over most of the territory in which 2,4-D was used. Except in areas where weed growth was succulent, and humidity relatively high, dusts (excepting esters) gave less uniform results than did sprays. Susceptible annual weeds, in the main, were readily killed, at even comparatively low concentrations. Wild mustard and stinkweed proved most susceptible; giant ragweed, Russian thistle and "pigweeds" (until seed commenced to form, when they became almost resistent) required rather stronger concentrations, but were readily killed. Perennial weeds, chiefly Canada thistle and sow thistle, while seldom eradicated, were severely checked, usually to a point of failing to set seed; concentrations of 2,4-D for perennial weed eradication should approach the maximum that the crop will permit, even to a point of causing slight crop damage.

In general 2,4-D when applied at lower concentrations (1/2 lb. acid per acre, or less) did not adversely affect crops under consideration. As the dosage increased above one-half pound, and especially with the ester, the crop showed typical 2,4-D effects -- delayed maturity, shorter stand, twisting of stems, etc.; yields in such cases usually were lowered. Spring wheat appears to have greatest tolerance, barley the least of the grains; flax is difficult to rate -- if the concentrations are kept low, flax undoubtedly can be safely treated. A careful analysis of a number of reports from farmers treating considerable acreages of flax in 1947, would indicate flax being a crop that will show marked yield increases when treated with 2,4-D at low concentrations.

Variety of grains and stage of growth of crop when treated are important factors. No data were obtained in Manitoba on varietal differences, and very little on stages at which to treat. Crops would seem most susceptible from emergence until about six inches in height; most tolerant in the active growing stage; and again, more susceptible at heading -- especially is this so with barley.

At the First Western Weed Conference, held in Regina, Saskatchewan, November 26-28, 1947, flax was included with the cereal crops as being sufficiently tolerant to treat with 2,4-D. Treatment of cereals was not recommended until growth was at least five inches (flax four inches) in height, or until three weeks after appearance of crops above ground. Rather lower dosages were recommended for flax than for cereals. Likewise a differentiation was made between formulations: less acid as amine salt was recommended than sodium salt, less again of ester than amine.

Following is the table of recommendations agreed upon by the Conference.

AMOUNTS OF 2,4-D ACID IN OUNCES PER ACRE TO USE
WITH DIFFERENT WEEDS AND CROPS
(As recommended by the Western Weed Conference for Use 1948)

Weeds	Formulation	Wheat, Oats, Barley, Rye		Flax	
		To Flower Ounces Acid	During Flowering Ounces Acid	To Flower Ounces Acid	During Flowering Oz. Acid
Highly Susceptible	Sodium Salt	7	10	6	8
	Amine	5	7	4	6
	Ester	4	5	3[1]	4[1]
Moderately Susceptible	Sodium Salt	8	12	7	10
	Amine	6	8	5	6
	Ester	4	6	3[1]	4[1]
Partially Resistent	Sodium Salt	-	-	10	10
	Amine	7	10	6[1]	6[1]
	Ester	5	7[1]	3[1]	4[1]

[1] The rates indicated may result in some crop injury, and should only be used where there is a serious infestation of weeds.

PRE-EMERGENCE TREATMENTS
R. S. Dunham, Leader

PRE-EMERGENCE TREATMENTS OF WEEDS IN CORN
By: F. J. Greaney - Manitoba

It is my pleasure to report to you this afternoon the results of two field experiments carried out at the University of Manitoba by Dr. P. J. Olson and Mr. Saul Zalik. I am sorry that Dr. Olson, who is busy with University classes, is unable to be here today to report to you, and I am sure you are sorry that I am here -- so we are all sorry.

Fortunately, as the Organization I represent gave some financial assistance to Dr. Olson in carrying out the 1947 experiments, I was able to follow their progress closely. I hope I can give you a satisfactory summary of the methods used and the results obtained.

Dealing with the first experiment -- The Pre-emergence Control of Weeds in Corn with 2,4-D.

In this experiment a mixture of weed seeds including Lamb's Quarters, Wild Mustard, Stinkweed, Wild Buckwheat, Hare's Ear Mustard, Green Foxtail, Pigweed, Ball Mustard, Russian Thistle and Stickseed was sown in a series of plots on May 22nd. Corn was planted in the plots, in rows, on May 23rd. Ten days later (June 2), two series of the plots were treated with 2,4-D (Butyl

ester). On one series, 2,4-D was applied at the rate of 2 lb. of acid per acre; on the other at 4 lb. per acre. The volume of spray per acre was 80 gallons.

Now for the results. There was a vigorous growth of all weeds on the untreated check plots. Treatment with 2,4-D gave almost complete control of all weeds except Russian Thistle, which grew normally. No visible damage to the corn at either the 2 lb. or 4 lb. rate was observed. The treated plots yielded approximately 3 times as much total dry matter as did the check plots. However, no statistically significant yield differences were observed between the 2 lb. and 4 lb. rates of 2,4-D. It should be mentioned in passing that the heavy weed growth on the untreated check plots very seriously reduced the yield of corn.

Coming now to the second experiment -- The Effect on Crop Plants of the Residual Effect of 2,4-D in the Soil.

The crops involved were: barley, flax, millet, alfalfa, and corn. These crops were sown in plots (replicated five times).

In this experiment two forms of 2,4-D were compared, namely, ester (Butyl) and sodium salt. The chemicals were applied on May 21st at the rate of one pound of acid per acre. The volume of spray used was 80 gallons per acre.

Each of the above-mentioned crops was sown in treated and untreated soil on five different dates, namely, May 17, June 3, June 16, July 2, and July 17. At the end of the experiment, yield of dry matter in pounds per acre was used as the criterion for determining 2,4-D treatment effects.

The results of this experiment may be summarized briefly as follows. The growth of barley, millet and corn was not adversely affected at any date of 2,4-D application. In regard to flax and alfalfa, none of the 2,4-D treatments significantly affected the yield on the first date (sown 4 days before the soil was treated). Flax showed a significant reduction in yield at the second seeding date only; whereas alfalfa showed a significant reduction at each of the second and third dates, that of the second being greater. No significant yield differences were observed between the ester and sodium salt treatments.

May I again express my pleasure at being able to present these results to you this afternoon.

PRE-EMERGENCE TREATMENTS OF WEEDS IN CORN

By: O. C. Lee - Indiana

This report will be brief because I only have one experiment to report on. We picked out a corn field on some of our good Indiana land, and made application of 1.5, 3, and 4.5 pounds of 2,4-D acid per acre. The corn in this field was planted on May 27, the 2,4-D was applied on the 4th of June. The corn emerged approximately three days after the application of 2,4-D. When corn yields were checked we found no reduction in yield where 1.5 pounds was applied

as compared to checks. We got a slight reduction in the yield with three pounds. In fact, the actual figures are 5.1 bushel reduction. With 4.5 pounds, the yield was reduced 5.5 bushels compared to checks. All three applications controlled common ragweed, giant ragweed or horse weed and did a fair job on cocklebur. I would say that it did only a reasonable job in controlling annual smartweed. About three weeks after the applications of 2,4-D with the exception of the 4.5 pound application, smartweed started to grow and as a result it was necessary to cultivate these areas to destroy these weeds so that they would not interfere with yield. Many farmers who have seen the results of pre-emergence treatment on corn are enthused about this method of weed control in corn fields. They feel that if wet weather follows planting so they cannot cultivate their corn, a pre-emergence treatment with 2,4-D would be good assurance against weeds and they could go fishing or take a vacation and not worry about their weeds and their corn.

Thank you Mr. Lee. Are there any questions?

Question. Was there any control on pigeon grass from pre-emergence treatment?

Answer. Dr. Willard. We had some control of pigeon grass by pre-emergence treatment.

Question. Could a sprayer be attached to the rear of the planter and thereby do the planting and spraying all in one operation?

Answer. Mr. Lee. Yes. However, our results this year indicate that we get better weed control if we apply the 2,4-D a little later. If applied later the effect of the 2,4-D will be there to check weeds for a longer period of time after planting.

Question. Could a small grain crop be treated with 2,4-D in which clover has been seeded?

Answer. Dr. Dunham. In our trials in Minnesota it would indicate that it would take about a month before clover is safe on land that has been treated with enough 2,4-D to control the weeds.

PRE-EMERGENCE TREATMENTS OF CROP PLANTS WITH 2,4-D AND METHOXONE

F. L. Timmons, Agronomist, Bureau of Plant Industry, Soils, and Agriculture Engineering, Hays Experiment Station, Hays, Kansas

(Mr. Timmons' remarks were based upon three abstracts entitled, "The Effects on Crop Plants of Pre-emergence Treatments with 2,4-D and Methoxone", and two abstracts entitled, "The Effectiveness of Pre-emergence Treatments with 2,4-D and Methoxone in Controlling Annual Weeds", which appear later in the Proceedings in the Report of the Research Committee, Section on Pre-emergence Trials summarized by R. S. Dunham.)

PRE-EMERGENCE TREATMENT OF WEEDS IN CORN

By: C. J. Willard - Ohio

We had quite an extensive series of pre-emergence trials in Ohio this year on which we determined yields. For several reasons it was not possible to leave them uncultivated and they were cultivated just the same whether they were treated or not. We learned from these tests that the treatment did not affect the yields of corn. We had 41 plots of that kind treated at two different dates, with amounts ranging from 1/2 pound per acre to 3 pounds per acre of 2,4-D acid, in the form of the butyl ester, the triethanolamine and the sodium salt. They were applied as dilute sprays four or five days after the corn was planted. At no time during the season was there any effect of these applications on the corn. Yield and height measurements were taken on the corn and there were no significant differences between the plots. In order to find out what would happen if we left the weeds to grow, we planted another series of plots on August 1st. That is not the time to plant corn in Ohio, but you can learn something about the behavior of corn and weeds at that time.

In the treatment of these plots we used concentrated spray, so we did not use the sodium salt, which is not sufficiently soluble. We used the triethanolamine in water, 5 gallons to the acre, the butyl ester in water, and in diesel oil at 6 gallons to the acre. The amount applied was 1, 2, and 3 pounds to the acre of 2,4-D acid as the amine salt and 1, 2, 3, and 6 pounds per acre of 2,4-D acid as the butyl ester.

Dr. Willard showed a series of slides illustrating these experiments. There were no differences between materials, and no visible injury to corn or soybeans, even at 6 pounds acid per acre.

One pound of acid nearly, but not quite, controlled the annual weeds. Two pounds or any higher rate controlled annual weeds, including annual grasses. Hedge bindweed was partly controlled, but there was no effect on Canada thistle and ground cherry.

PRE-EMERGENCE CONTROL OF WEEDS IN CORN

By: Dale E. Wolf, New Jersey

It gives me great pleasure to be able to present some of the results we have obtained from our pre-emergence work in New Jersey. I'll go through the tests briefly and give you the results as we have them. In 1946 we put out a pre-emergence test using 2,4-D and the results were reported in the American Society of Agronomy Journal. In 1947 we expanded this test to include 4 corn hybrids with more extensive replication. The hybrids used were Ohio C88, Pioneer 332, U. S. 13, and New Jersey No. 4. Four replications were used in these tests and the soil was a Sassafras loam. Rates of applications of 2,4-D were one and one-half pounds, two and one-half pounds and three and one-half pounds per acre. The sodium salt of 2,4-D was used in this experiment. One of these treatments was put on the same day as the corn was planted and the other eight days after the corn was planted. We originally intended to apply the second treatment 5 days or 6 days after the corn was planted but weather did not permit this. Good control of both the annual broad-leaved and grass weeds was obtained. In the pound and a half treatment, there was little injury to the

corn. At the two and a half and three and a half pounds per acre treatment, there was a reduction in seedling emergence and a slight reduction in the yield. It is well to say that in this test, those plots which were treated were not cultivated throughout the season. The check plots were cultivated four times and hoed to eliminate weed competition. The best treatment in this test was the pound a half rate applied eight days after the corn was planted. Yields on the plots receiving this treatment did not differ significantly from the control plots.

It seems to me that the factors which really play an important part in 2,4-D pre-emergence as we see it in the East are: first, soil type; second, rainfall; and third, organic matter content in the soil. I believe this gives you the brief picture of what we have done of 2,4-D pre-emergence. This work was carried on as a cooperative project by Dr. J. C. Anderson and myself.

I want to take a couple of minutes to tell you of the cyanamid pre-emergence which we tried this year for the first time. The corn hybrid was U. S. 13. The idea of the test originally was to see if we could obtain weed control and perhaps get stimulation of the corn which would result in increased yield. Two types of cyanamid were applied -- the granulated and the pulverized, using three rates of treatment, one hundred fifty pounds, three hundred pounds and six hundred pounds per acre. In one case these were raked in, in the other case they were left on top of the soil. The soil in this test was a loamy sand. These were applied the same day the corn was planted. The six hundred pound rate resulted in an 87 per cent decrease in weed population. These treatments eliminated the need for the first two cultivations in this test. Yields indicated that the three hundred pounds of granulated and the six hundred pounds of pulverized and granulated cyanamid had doubled the yield in comparison to the check plots. This pretty well summarizes our work in New Jersey on pre-emergence treatment of corn using 2,4-D and cyanamid. I want to emphasize the fact that these results on the cyanamid test were from one year's test and therefore, should not be construed as general recommendations. We are going to carry out both of these tests again next year.

EVENING SESSION - DECEMBER 10

Slide Fest - Keith Barrons, Chairman

This consisted of a two hour session of showing motion pictures and slides on weeds, weed eradication work, and weed research work by commercial, state, and federal research workers. The discussion, with questions and answers, made the meeting interesting and instructive.

After the slide fest, everyone went to the exhibit room where refreshments were served by the Kansas weed workers. Refreshments consisted of cider, donuts, apples, smokes, and cold pop.

The exhibits were viewed during and after refreshments.

MORNING SESSION - DECEMBER 11

WEED CONTROL IN AGRONOMIC CROPS
L. W. Kephart, Chairman

NEWER HERBICIDES
E. D. Witman, Leader

Sodium Isopropyl Xanthate: A New Herbicide and Vinekiller

By: LUTHER L. BAUMGARTNER - B. F. Goodrich Company

A new chemical that can be used as a pre- or post-emergent herbicide has been discovered and is now being investigated by the Biochemical Laboratory. This herbicide, though not as powerful as 2,4-D, possesses features to be desired in a weedkiller and can be used safely by even a novice gardner. It can be formulated easily as a dilute spray, or concentrate spray. Dusts are effective but require special formulation. It is non-corrosive and non-contaminating to spray equipment and can be stored without danger of deterioration.

From one to two applications of this herbicide completely eliminated the need for a hoe in an experimental garden of nine common vegetables. Preliminary tests indicate that it is suitable for weeding strawberry beds if applied before or after the fruit is produced. In another experiment weeds were controlled under 3-year old apple trees with no injury to the trees, even though the trunks were sprayed heavily.

This chemical, sodium isopropyl xanthate, provides effective weed control at concentrations of from 0.5% to 1.0% and from 13 to 20 pounds per acre, depending on the size and age of the plants. It is most effective against plants of the primary stages of succession and is only partially effective against woody plants.

Effective potato vine kill was obtained using spray formulations containing from 1.0% to 1.5% of the chemical. It also showed promise for defoliating certain crops such as cotton.

Allyl Chlorophenyl Carbonate: A New Organic Chemical Herbicide

A new herbicide effective against certain grasses, thistle, and certain broadleaved plants has been discovered and is now being investigated by the Biochemical Laboratory. This chemical, allyl chlorophenyl carbonate, has been tested under laboratory and field conditions by State and Federal Agricultural Stations and gives promise of supplementing 2,4-D type herbicides.

It is a growth-regulating substance that produces marked growth inhibition. Plants with apical meristems such as stinging nettle (Urtica dioca) cease growing after application of the chemical but as much as a week may elapse before the plants are completely dead. Members of the lily family, as exemplified by the common onion, may exhibit no external symptoms of the action of the herbicide until the bulb is well rotted. Carrots and burdock react to it by developing acute necrosis at the juncture of leaves and root stock. Its reaction on all grasses has not been conclusively demonstrated but the following representatives of different groups of grasses have been controlled:

Wheat, Triticum sp.
Corn, Zea mays
Timothy, Phleum pratense
Rye, Secale cereale
Crab grass, Digitaria sp and Eleusine indica
Orchard grass, Dactylis glomerata
Barnyard grass, Echinochlca crusgalli
Blue grass, Poa, spp
Yellow fox tail, Setaria, spp.
Cattail, Typha sp., can also be killed with this herbicide.

This chemical is readily soluble in organic solvents and has been very effective as the active ingredient in fuel oil sprays. Preliminary tests indicate that it will find wide application for fortifying oil sprays of all types. Divers emulsifiers were found to be suitable for preparing water emulsions but the most effective emulsions contained 20 parts oil.

As with many herbicides, the activity of this one is subject to air temperatures. On hot days a concentration of 0.125% is sufficient to obtain good control but from 0.5% to 1.0% may be required in cool weather.

Selective herbicidal activity has been indicated between grasses and certain broadleaf plants. For example boneset, Eupatorium sp.; pigweed, Amaranthus retro-flexus; ragweed, Ambrosia spp.; and sheepsorrel, Rumex acetosella, display resistance to this herbicide when it is used at the above rates of application.

Calcium Cyanamid, Aero Cyanate and Sodium Cyanamid as Herbicides
By: F. T. Boyd - American Cyanamid Company

Pulverized calcium cyanamid has been used as an herbicide in dust form for many years. In certain drier areas and in seasons of infrequent rains or dews, insufficient moisture has prevented this material from becoming wholly effective. This fact has led to the development of two new materials: AERO Cyanate weedkiller, in which potassium cyanate is the active principle, and Sodium Cyanamid. Both of these compounds are readily soluble in water and may be applied with low pressure spray equipment.

Aero Cyanate is a very active contact herbicide and has proven effective particularly for control of small weeds in onion fields. In general, a 1% spray solution of this material applied toward the base of small onion plants, and increased to 2 to 3% solutions for older onions has given satisfactory weed control. This chemical has been particularly selective for such weeds as purslane or pussley, pigweed, and chickweed in onion fields.

Sodium Cyanamid may also be used as a contact spray material, and due to the fact that it is somewhat hygroscopic in nature, it has been found effective even in the drier climates when applied in dust formulations. This material is applied at approximately 25 pounds per acre for most herbicidal purposes and contains about 30% nitrogen which may prove of value to the growing crop.

2,4,5-Trichlorophenoxyacetic Acid for the Control of Rubus and Other Plants

By: W. C. DUTTON - Dow Chemical Company

2,4,5-trichlorophenoxyacetic acid is not new to those who have been familiar with progress in the use of chemicals for weed control, but recent developments indicate that this compound has an important place in the control of several undesirable plants.

Extensive research has indicated that 2,4-D is highly effective for the control of many species of woody plants that often dominate highway, power line and railroad rights of way and other areas. The fact remains, however, that this compound is not highly satisfactory on some species. Outstanding in this group which is resistant to 2,4-D are the brambles which includes several species of Rubus. The isopropyl ester of 2,4,5-trichlorophenoxyacetic acid has given outstanding results on blackberry (R. allegheniensis), red raspberry (R. strigosus), black raspberry (R. allegheniensis), and dewberry (R. procumbens). Initial response to concentrations of 1000 to 1500 ppm was about like that from 2,4-D on plants susceptible to it and within two weeks the leaves turned yellow and dropped and many plants were dead within one month. A little regrowth developed from low buds.

It was also used on other species known tohave some degree of resistance to 2,4-D. Two instances of high susceptibility to 2,4,5-trichlorophenoxyacetic acid were found in strawberry (Fragaria virginia) and ground cherry (Physalis pubescens). The common potato is also susceptible to it.

Several woody species that are susceptible to some degree to 2,4-D responded as much or more to 2,4,5-T. On the other hand, several species, including bur oak (Quercus macrocarpa), white ash (Fraxinus americana) and milkweed (Asclepias syriaca) were equally resistant to both 2,4-D and 2,4,5-T.

Combinations of the two materials have given excellent results and may have an important place under certain conditions.

2,4,5-T is not being suggested to take the place of 2,4-D generally, but it certainly seems to merit careful evaluation on the species that do not respond well to 2,4-D.

Sodium Pentachlorophenate and Pentachlorophenol As New Herbicides

By: L. V. SHERWOOD - Monsanto Chemical Company

Sodium pentachlorophenate has been used as a herbicide longer than 2,4-D, and, therefore, can scarcely be considered a new herbicide in a conference such as this where 2,4-D is considered an "old timer". Sodium pentachlorophenate (Santobrite) is an old timer in Hawaii where it is the chief herbicidal chemical and is being used in terms of millions of pounds annually.

Santobrite (Sodium pentachlorophenate) can be applied either in water or in an oil-in-water emulsion. Applied to the soil either before or after the crop plants emerge, but each time before the weed seedlings emerge (pre-emergence),

either type of formulation effectively prevents weed growth in sugar cane and pineapple in Hawaii. The oil formulation is best suited when applications are made on emerged weed seedlings (post emergence).

Soil applications of 15 to 35 pounds of Santobrite per acre, made immediately after cane or pineapple are planted, prevent all weed growth from 30 to 90 days. Although up to a 20 or 25% solution of Santobrite in water can be prepared, the amount of water is not important except to assure uniform distribution.

Although highly successful in Hawaii, it should not be assumed that formulations and methods used in Hawaii can necessarily be adapted directly in the United States. However, preliminary tests indicate that there are real possibilities of successful adaptations, particularly in the corn and cotton belts of the United States. Certainly the prospects of growing crops to full maturity without weeds and without cultivations, as is successfully done in Hawaii, is a highly interesting prospective goal.

Pentachlorophenol (oil soluble), the parent chemical of sodium pentachlorophenate (water soluble), must be dissolved in oil for herbicidal use. This chemical is finding a place in many herbicidal formulations, especially if they contain oil. Its addition increases the herbicidal activity of the oil and sometimes other chemicals in the formulation. While the use of pentachlorophenol is in the experimental stages, preliminary tests with it are highly encouraging. It is particularly encouraging, now that herbicidal oils are becoming available which will dissolve sufficient pentachlorophenol for optimum effectiveness. Only recently has this been the case.

Considering the highly successful use of sodium pentachlorophenate in Hawaii in terms of millions of pounds annually, and considering the encouraging preliminary results with both pentachlorophenol (Santophen 20) and sodium pentachlorophenate (Santobrite) in the states, it appears that you will be hearing more and more about these chemicals as time goes on.

Dr. Whitman: Don't go away Sherwood. I am sure some of you will have questions to direct to Dr. Sherwood, and it probably would be best to discuss them now. Dr. Dunham has a question.

Dr. Dunham: Is the material selective?

Dr. Sherwood: No, we do not think of these chemicals as being selective in the sense you do 2,4-D. This is one advantage they have, particularly for soil treatments, in that regardless of the weed that tries to emerge, it is likely to be killed.

Dr. Willard: What is the cost?

Dr. Sherwood: This question always comes up doesn't it? Naturally, the manner of formulation and rate of application will affect the per acre cost. Many times the addition of these chemicals actually reduces the cost of the formulation used, in the sense that it cuts back the amount of other materials needed such as oils and arsenic for the same herbicidal effectiveness. The cost of pentachlorophenol or sodium pentachlorophenate will be in the neighborhood of 20¢ a pound.

Mr. Kephart: Something was said about sodium pentachlorophenate being a sneeze powder. I would like to have you mention any precautions you have used in your handling the chemical.

Dr. Sherwood: I'm glad you brought that up. Usually, anyone who starts using the chemical, and is not familiar with it, will open the package and the dust starts flying. The operator starts sneezing.

There are ways and means of reducing this. Our men work daily with its manufacture, and some of us have done considerable herbicidal experimentation with it, with no particular discomfort if we use care.

One way of reducing the dust is to open and empty the package or container, keeping it immersed in the water to be used as a diluent. We usually make up a concentrated stock solution and handle it in liquid form wherever possible. Sometimes this enables preparation in the laboratory under a hood with an exhaust fan, or a respirator can be used.

It appears that the irritating quality is most objectionable while dealing with small lots for experimental purposes. Once it enters large scale field applications, methods are more easily worked out to avoid these complications, as is evidenced in Hawaii where experimental staff and field men use it constantly with no complaint. While in the Islands, I inquired about this very point, and was answered somewhat as follows. "We are so satisfied with the results that we are willing to take a little disagreeableness along with it. Anyhow, if it irritates the protoplasm of the human being, it must also have some effect on the protoplasm of the plant."

Plant Responses to O-Isopropyl N-Phenyl Carbamate

By: W. B. ENNS, Jr. - Camp Detrick, Md.

In the past few months considerable publicity has been given to isopropyl N-phenyl carbamate as a selective killer of grasses. In many respects this is unfortunate since some of these claims have not been substantiated by proper experimental evidence. With the advent of 2,4-D claims were made that it had no effect upon grasses. More recently, this carbamate has been popularized as the "2,4-D for grasses", implying that it has no effect upon broadleaf plants. We now know that neither of these claims is true. While different species vary markedly in susceptibility to top applications of 2,4-D at established stages of development, virtually all grasses and broadleaves, which have been tested, show reactions when the germinating seeds are exposed to it. The responses vary from one species to another. Studies with the carbamate have also shown the germinating stage to be the susceptible one, however, the carbamate does not cause obvious reactions in all plants.

Because of the ease and rapidity of testing plants at the germinating stage, over 50 species were tested by applying the carbamate in solution to the soil immediately after planting at a rate of 10 mg./1/2 gal. pot. This is roughly equivalent to 7 lbs. per acre. Of 13 narrowleaf species tested in this study, all were affected by the carbamate. Oats, barley, wheat, rye, orchard grass, timothy, rye grass and Red Top failed to emerge from the soil. Corn, rice, sudangrass, millet and sorghum were less affected by the treatment, but most of these did not develop beyond the plumule leaf stage. Of 39 broad

leaf species tested at the germination stage, 15 showed some reaction to the substance. Six of these largely recovered from the treatment, whereas 9 were permanently inhibited. These were buckwheat, flax, morning-glory, tobacco, tomato, petunia, pepper, cucumber and watermelon. Since there is little published information on the symptomatic responses of many plants to this carbamate, the following few minutes will be devoted first, to presenting the typical responses induced when crop plants are exposed to isopropyl N-phenyl carbamate by various methods, and second, to pointing out possible uses for compounds of this general type.

Slide 1. Germinating cereals are particularly susceptible to this substance at the germination stage. This slide shows the typical response of the small grains and the cultivated grasses enumerated above. Note the enlarged coleoptile and stubby, bulbous roots. These did not develop beyond this stage. In all the slides to be shown the control is on the left.

Slide 2. The broadleaf species varied in response to the soil treatment from no emergence in some cases to no apparent effect in others. All the affected broadleaves showed similar gross responses. These are characterized by shortened and thickened hypocotyls, lack of expansion of cotyledonary leaves and the development of only a single radicle. Such plants developed no further than shown in these slides. This slide is of cucumber which is typical of the response of watermelon also. It is interesting that three other members of the gourd family, namely, pumpkin, squash and gourd, were not seriously inhibited by the same level of treatment.

Slide 3. Shows the response of a cultivated morning-glory. Note the dark color of the cotyledonary leaves. Tomatoes reacted similarly. All members of the nightshade family tested were inhibited by soil treatment at the germination stage.

Slide 4. Buckwheat did not emerge from the soil, nor develop beyond the stage shown in this slide. Flax reacted similarly to buckwheat. Note that the same general response occurred here as in the case of the other broadleaf species shown.

Slide 5. Young oat plants treated by soil application show this type of gross response. The plants cease to elongate, become dark blue-green in color and after 10 days to 2 weeks die.

Slide 6. The gross response of oats is further characterized by lack of elongation of the roots, swelling of the root tips and a profuse development of root hairs. (Nutrient solution exposure -- 1 p.p.m.).

Slide 7. Shows untreated oat roots. Note position of the root hairs with respect to the tip and their relative number (grown in nutrient solution).

Slide 8. The coleoptilar region of oats becomes swollen and the coleoptile is ruptured as a result of the enlargement of the enclosed leaf tissues (3 days exposure to 10 mg./pot).

Slide 9. Since in cereals or grasses there is no epinastic bending or proliferation of tissues as occurs in broadleaved plants treated with 2,4-D certain histological and cytological studies have been made. This slide shows a

longitudinal section of the growing point of an untreated oat plant 14 days old. Note the densely stained cells, their relative size and the number of leaves which have developed.

Slide 10. In this slide is shown a longitudinal section of a treated 14-day old oat plant (at the same magnification) after exposure to the substance in soil for 144 hours. No additional leaves developed after treatment. Cell division has ceased in the apical cells of the bud. These cells are greatly enlarged and there is an increase in nuclear material as is evidenced by the giant nuclei.

Slide 11. Cytological studies have shown that effects are induced following exposures of 1 to 6 hours to the carbamate, hence to study the relation between the abnormal cytological effects and subsequent growth, 4-day old oat plants were exposed for varying intervals to the carbamate in soil cultures. Note that following 18-30 hours exposure very few plants survived. These survival data correlate well with the cytological abnormalities which are observed following these various exposures.

Slide 12. Thirty-two days after exposure for only 12 hours to 5 mg./pot, oat plants had made little new growth. There is a very great inhibition of shoot growth. Note that a tiller has developed from the coleopitlar node.

Slide 13. This slide shows an oat plant (on right) 32 days after exposure to 5 mg./pot for 24 hours. Note the rosette growth habit and marked delay. Control on left.

Slide 14. Shows an oat plant on right which has been very greatly delayed in heading as a result of exposure to 5 mg. of the substance per pot for only 6 hours in soil. Control is on left.

Slide 15. Now let us turn briefly to some responses of established broadleaf plants to soil applications of this carbamate. Irish potatoes treated when 2" to 3" in height develop a rosette habit of growth. The leaves become thickened and brittle.

Slide 16. Subsequently, axillary shoots develop but the central stem bud is permanently suppressed. This new growth was initiated 14-17 days after treatment and after 38 days had this appearance.

Slide 17. Tomatoes 8 inches in height treated by soil application respond somewhat similarly to the Irish potatoes in that the central stem ceases to elongate. The plant has a "bunchy" appearance. Leaves are rugose. The bending is likely due to a weakened root system rather than to true epinasty. (12 days after treatment).

Slide 18. Twenty-eight days after treatment axillary shoots develop on tomato as in the potato while the central stem bud is suppressed.

Slide 19. Cereal plants grown under field conditions normally have deep and extensive root systems after reaching knee height, and high applications of the carbamate to the soil are required in order to induce any response. However, oat plants exposed to the carbamate in gravel nutrient culture at 1.0 or 5.0 p.p.m. are inhibited in shoot elongation at any state of development from

seedling plants to those in the late boot stage. Stage of development does not appear important when all roots are exposed. In view of the relatively low concentration causing injury by nutrient solution exposure, it would appear that top exposure would cause similar inhibition. (45 day old plants exposed for 11 days).

Slide 20. Oat plants sprayed or dipped in solutions of the carbamate when 15 inches in height showed no response to the treatment. If the spray fell on the soil, the plants died (extreme right). (A, control; B, 1000 p.p.m. dip; C, 5000 p.p.m. dip; D, 5000 p.p.m. spray (soil covered); E, 5000 p.p.m. spray (soil uncovered).

Slide 21. However, after the internodes elongated and the panicle was more exposed to top applications than in the seedling stage, responses were induced as in the case of the nutrient solution exposures.

Slide 22. Responses can be induced in buckwheat by top applications which is further evidence that the morphology of plants is important in inducing responses with this substance by top application. In such plants the apical bud is exposed. Note that the internodes have not elongated and that flowering is greatly delayed. Such plants later developed axillary shoots as occurred in potatoes and tomatoes.

Slide 23. Rice treated by applying the carbamate to the irrigation water is inhibited in shoot growth. The plants become dark green in color. Note that the axillary buds have formed many new tillers. The axillary buds appear to develop in all these species when treated at sub-lethal levels. The specific inhibition of the central stem or culm growing points seems to destroy apical dominance thus, stimulating the axillary buds to develop.

Slide 24. As previously pointed out, 2,4-D has not been found to be selective in its effect when germinating seeds are exposed to it. The flat in the background was treated with 2,4-D at planting time. Note that neither of the six species established itself. Left to right, Kidney bean, barley, cotton, buckwheat, soybean and oats.

Slide 25. In contrast, when the carbamate is similarly applied to the same crops at planting time some of the broadleaf plants show no obvious reaction. Barley, buckwheat and oats failed to establish.

Slide 26. The same plants shown in the previous slide were treated at the stage shown in this slide. The flat on the left was sprayed with 2,4-D in an aqueous solution and the flat on the right with O-isopropyl N-phenyl carbamate in an aqueous fomulation. (Carbamate 10 lb./A.; 2,4-D 2 lb./A).

Slide 27. Six days later, it is to be noted that the 2,4-D spray treatment killed the broadleaf species whereas the cereals showed no obvious effect. The flat on the right (which was treated at planting time with the carbamate and again at the later stage) did not respond to the carbamate other than showing a slight degree of burning resulting from the solvent used in the formulation. It is obvious that 2,4-D acts distinctly different on established cereals than on germinating ones. The carbamate failed to cause injury to the established broadleaves as was the case when applied to these at the germination stage. In concluding I would like to make the following points which may have some agronomic implications:

1. Isopropyl N-phenyl carbamate is not limited to monocotyledons in its effects, although some broadleaves tolerate the compound without obvious effect. Its specificity of action upon certain species within a given family, such as the Solanaceae and Cucurbitaceae, suggests that similar relationships may exist so far as other plant growth-regulators are concerned.

2. Although this compound does not appear promising for selectively killing grassy weeds, its unique effects on the meristematic cells of the root and shoot and its specificity of action on certain grass and broadleaf species offers considerable encouragement. The demonstrated differential response of various crop species to this carbamate certainly points toward the need for a more comprehensive screening of the effects of many plant growth-regulators on many different species. Perhaps, ultimately, we may find compounds which will remove most undesirable species without causing concurrent injury to a growing crop.

3. In view of the inhibitory effectiveness of isopropyl N-phenyl carbamate on certain cultivated grasses at the germination stage and its lack of effect on some broadleaf plants, compounds of this nature might be applied to the soil with impunity to inhibit certain susceptible obnoxious species during the germination and seedling stages without causing concurrent injury to a non-susceptible crop species such as beans, peas, cotton, clovers, etc.

4. The distinctly different morphology of grass plants as compared to broadleaf plants must be recognized as an important factor in determining whether effects can be induced by this carbamate through top application. The results with cereals have shown that in the early stages, effects are most easily induced by soil treatments, whereas top applications are ineffective. On the other hand, after the internodes have elongated the growing point is protected by only one or two leaf sheaths and top applications effectively inhibit inflorescence development. This implies that cereals would be damaged by top applications of this substance if applied before the root system is well-established (i.e. young seedling stage) or after the jointing stage. Hence, this compound is of doubtful value for selectively controlling weeds in the cereals.

5. Since at sub-lethal levels, the carbamate causes delay in flowering of plants, agronomists investigating the newer plant growth-regulators should not overlook the possible benefits of such compounds for purposes other than weed control. For example, a compound that causes delay in flowering might be used on pasture grasses to keep them in a vegetative state rather than becoming woody and unpalatable. Such substances might particularly be effective in inhibiting a forage grass, such as orchard grass, until it is past the critical photoperiod, after which the plants normally will not flower.

Ammonium Trichloro Acetate

By: T. C. RYKER - E. I. Du Pont de Nemours Company

Ammonium trichloroacetate (ATA) on the basis of our initial testing and the preliminary tests this past season by a number of Federal and State investigators has shown considerable promise as a herbicide for certain perennial type grasses such as Johnson, Quack and Bermuda grass. In the beginning I want to emphasize that we know much too little about its herbicidal properties but it is hoped that from extensive testing planned for this coming season we will

answer many of the present questions.

Chemical properties: The initial tests were with a 20% aqueous solution but plans are for a dry crystalline water soluble material. It is somewhat corrosive to metals and very little is known of its toxicity to man or livestock. Several investigators have reported slight skin irritation from direct contact with the material.

Herbicidal Action: It is a contact non-selective herbicide when applied as a spray on growing plants. When applied on the soil surface it inhibits (from seed in the soil) seedling growth of monocots to a greater extent than dicots. On grasses the killing action especially of underground parts is slow and it may take 2 to 3 months for rhizomes to die. It has appeared to be more effective under moist conditions than under dry conditions. Indications are that ATA is translocated to some degree in Johnson grass. It does not appear to have much killing action on non-germinating seed. The period of soil toxicity is relatively short and at most 2 to 3 months. Some broadleaf plants will come back almost immediately after application.

Tests and dosages: For eradication of old stands of Johnson grass, quack grass and Bermuda grass from 1/4 to 3/4 pounds per 100 sq. ft. have been indicated. Under moist conditions surface application has looked most promising but under dry condition application to the foliage has looked best. All tests have been with high gallonage sprays. Other grasses appear to be equally or more susceptible than the above. Results with nut grass has been quite variable. Johnson grass and other grass seedlings in the 2 to 3 leaf stage have been controlled with application of 30 to 40 pounds per acre applied either as a concentrated or a dilute spray. Lower applications are indicated with pre-emergence application for the control of grass seedling. These low rates have indicated possibilities of its use, especially as pre-emergence treatment for the control of grass type weeds in various broadleaf crops.

MISCELLANEOUS TOPICS
W. C. Dutton, Leader

Controlling Johnson Grass and Other Weed Growth On Irrigation Ditchbanks

By: L. S. EVANS - Bureau Plant Industry, U.S.D.A. Washington, D.C.

Mr. Chairman, and gentlemen. I would like to show some colored slides which show the results from one year's experiments at Phoenix, Arizona in an effort to find more effective methods of controlling Johnson Grass and other weed growth on irrigation ditchbanks. Repeated applications of diesel oil is a common practice in some of the areas of the arid Southwest where full advantage can be taken of the toxicity of the oil under the prevailing high summer temperatures and low humidity. You can see that this represents environmental conditions quite different from those described by some of the previous speakers.

In these tests conducted in the Salt River Valley of Arizona, field plots were treated with various oils, oil-water emulsions and other materials applied with a hand boom and a 1/4 inch gear pump powered by a one horse-power gasoline engine.

This first picture shows undisturbed Johnson grass effectively obstructing the water flow in a small irrigation lateral. The next picture shows the degree of control which resulted from applications of diesel oil made at four week intervals during the season. A total of six applications eliminated most of the Johnson grass but still left a fair cover of Bermuda grass to stabilize the soil and prevent erosion of the ditchbanks. Applications were at the rate of 160 gallons per acre initially but dropped to 80 gallons per acre as the comeback of the Johnson grass decreased.

The next picture shown the results from seven applications of an oil-water emulsion fortified with 1 quart of a di-nitro compound (Dow General). This combinatinn is somewhat less expensive than a straight oil application because only about 30 percent oil is used in the mixture. It is less toxic than straight oil but gives effective control but we have not yet obtained eradication with this material.

It was found that when using the less toxic materials it is advisable to spray at frequent intervals, at least not over 4 weeks apart in order to effect a complete knockdown of the foliage. Longer interval permit a more mature growth to develop which becomes increasingly resistant with age.

This slide shown the complete eradication of Johnson grass which resulted from the application of 500 gallons per Acre of Shell Weedkiller No. 20 made in four treatments. Note also that Bermuda grass and other ditchbank weeds have been eliminated. The next slide shows results from application of another special formulation of weed killing oil. General Petroleum Aromatic No. 4. In this case and in the previously described treatment the aromatic content of the oils result in pronounced color changes of the foliage.

This slide shows the contrast between spraying Johnson Grass at four week intervals (on the left) and at six week intervals (on the right). In this case a mixture of equal parts diesel oil and water were used with a suitable emusifier. Water in this case simply serves as an extender and permits more thorough coverage of the foliage which is necessary when using a contact or knockdown herbicide.

It is a common practice in Arizona and California to use oil sprays as a "chemical fallow" method in citrus groves to control grasses and other weeds. This method has been successfully followed for a number of years with no noticeable decline in productivity of the trees or the quality of the fruit. The oil treatment has the further advantage of avoiding severe root pruning which accompanies mechanical cultivation and also avoids serious soil compaction which is a major problem in the low organic irrigated soils of the Southwest. This slide shows the effective control of Johnson grass obtained in a citrus grove using the oil treatments. The next slide will show similar results obtained in a Pecan grove.

The last slide shows one of the common methods used in the Imperial Valley of California for controlling undesirable vegetation on irrigation delivery systems and drains. This weed burner uses diesel oil for fuel but the practice of burning is giving way in many cases to the more convenient and more comfortable application of the oil to the foliage rather than flaming the plants with a burner.

2,4-D Plus Cultivation Plus Cropping As A Means of Treating Field Bindweed

By: F. L. TIMMONS - Bureau Plant Industry U.S.D.A. Hays, Kansas

(Mr. Timmons' remarks were based upon three abstracts entitled "The Effectiveness of Different Combinations of Intensive Cultivation and Growing Competitive Crops With 2,4-D Treatment in Eradicating Field Bindweed", "The Effect of Intensive Cultivation of Field Bindweed Before andAfter Spraying With 2,4-D on Efficiency in Eradication", and "Effect of Shoot Cutting of Field Bindweed at Different Intervals After Spraying With 2,4-D Upon the Effectiveness of the Spray Treatments", all of which appear later in the Proceedings in the Report of the Research Committee, Section on Results of Non-Uniform and Miscellaneous Experiments compiled by W. C. Dutton.)

AFTERNOON SESSION

PHASES OF REGULATORY PROGRAM

Bernhard C. Swenson, Chairman

Explanation of the Principal Features of the Federal Insecticide, Fungicide, and Rodenticide Act

By: E. A. WALKER - U.S.D.A. Washington, D.C.

It is indeed a pleasure to have this opportunity to be present at this annual Weed Control Conference. Your President, Mr. Hanson informs me that your organization is very much interested in the Federal Insecticide, Fungicide, and Rodenticide Act, which became a law on June 25 of this year, replacing the Insecticide Act of 1910. This new Act greatly extends the coverage relative to the sale and marketing of economic poisons, since it applies to rodenticides, herbicides and devices intended for pest control, in addition to insecticides and fungicides which were covered by the Insecticide Act of 1910. Devices covered by the Law do not include equipment such as sprayers and dusters used for application of economic poisons when sold separately from them, or equipment such as hoes used against weeds. If the equipment is sold with the economic poison -- as, for example, an insecticide in a garden duster or an aerosol dispenser represented to contain an insecticide -- the whole is subject to the act. Under the law, a device is misbranded if its labeling bears any statement, design, or graphic representation relative thereto which is false or misleading in any particular.

According to the Act the term "herbicide" means any substance or mixture of substances intended for preventing, destroying, repelling or mitigating any weed. The term "weed" means any plant which grows where not wanted.

According to the law, a product is an economic poison if it is intended to be used as an insecticide, fungicide, rodenticide, or herbicide. The definition is substantially the same as the definition in the Insecticide Act of 1910 for insecticides and fungicides and is interpreted as covering substances for such use, either as packed or after dilution with some substance or substances. Examples are fly spray concentrates intended to be mixed with kerosene, and butyl ester of 2,4-D acid to be mixed with water for use as a herbi-

cide. Products which are intended for economic poison use only after a manufacturing process, such as grinding to dust form or compounding with other constituents, which cannot readily be carried out without special equipment, are not considered to be economic poisons. For example, crude cube root, which must be powdered or extracted before use, is not regarded as an insecticide; but cube powder, which is used directly or after mixing with talc or water, is so regarded.

A single substance may have several uses, some of them for economic poison purposes. For example, sulfur may be used to make sulfuric acid. This acid when diluted may be used as a herbicide to kill weeds in a field of carrots. Sulfur may also be used to vulcanize rubber, or as a fungicide on plants. 2,4-D may be used as a herbicide or it may be used to prevent fruit drop in apple orchards. Stoddard Solvent may be used as a weed killer or it may be used as a cleaning fluid. A substance of this character is not considered to be an economic poison as long as it is sold only in general channels of trade for that substance and there is no intent that it will be used for economic poison purposes.

One of the most significant features of the new act is the provision which requires all economic poisons to be registered with the U. S. Department of Agriculture before they can be marketed in the District of Columbia, Territories, or in interstate commerce. It is not required that devices be registered.

The law provides that an applicant, to obtain registration of an economic poison, must file with the Department of Agriculture a statement including:

1. The name and address of the registrant and the name and address of the person whose name will appear on the label, if other than the registrant.

2. The name of the economic poison.

3. A complete copy of the labeling accompanying the economic poison and a statement of all claims to be made for it, including directions for use.

4. If required by the Secretary, a full description of the tests made and results thereof upon which claims are based.

Unless it appears on the labeling, a statement of the name and percentage of each active ingredient and any pertinent information concerning the inert ingredients should be submitted with the application for registration.

Registration is intended as a method of bringing economic poisons and the claims to be made therefor to the attention of the Department of Agriculture so that immediate steps can be taken to correct inaccurate or misleading statements before the products are marketed. Registration of a product does not mean that the Department approves the claims made for it, and registration cannot be used as a defense for commission of any offense prohibited by law. However, the labeling of every economic poison offered for registration will be closely scrutinized and if it does not appear to comply with the law, the applicant will be advised of changes considered necessary and given an opportunity to revise the labeling.

Registration may be obtained by the manufacturer, packer, distributor, or shipper of an economic poison. When a product is registered, it may be

marketed without additional Federal registration as long as it remains in the manufacturer's or registrant's original unbroken immediate container and the claims for it do not differ in substance from the representations made in connection with its registration. Blank application forms have been prepared by the Department and are available on request. All rodenticides and herbicides must be registered by December 25 of this year; and all insecticides and fungicides must be registered by June 25, 1948.

Under the law, the words "label" and "labeling" have different meanings. A "label" is defined as meaning the written, printed or graphic matter on or attached to the article or to the container or wrapper of the retail package. The term "labeling" includes the label and all written, printed, or graphic matter accompanying the economic poison or device at any time. If the label or literature accompanying the article refers to a booklet, circular, or other literature, or directions not accompanying the article, such booklet, circular, other literature, or directions for use are included in the term "labeling". Current official publications of the U. S. Department of Agriculture and Interior, the U. S. Public Health Service, State Experiment Stations, State Agricultural Colleges, and other similar Federal or State institutions authorized by law to conduct research in the fields of economic poisons may be referred to in the literature accompanying the article without becoming a part of the labeling. It should be noted, however, that this exemption applies to current official publications of the agencies indicated.

The label should contain the ingredient statement, the name and address of the manufacturer, registrant, or person for whom manufactured, the name of the article, the net contents, any warning or caution statement which may be necessary. For economic poisons which are highly toxic to man, the skull and crossbones, the word "POISON" (in red) and the antidote statement are required to appear on the label. These statements, except the ingredient statement under certain conditions, are not required to appear on that part of the package which is displayed under customary conditions of purchase but must be sufficiently prominent and in such terms as to render them likely to be read and understood by the ordinary individual. The law provides that directions for use of an economic poison must be adequate. This does not necessarily mean that they must include all possible uses of the product under all conditions. In the case of some products having many uses and requiring different precautions in different parts of the country, this would be difficult, if not impossible. What constitutes adequate directions for use will vary with the product. In the case of a well-known, standardized material, it may be sufficient to give directions for the principal uses by the trade to which it will go and precautions against known dangers, together with general instructions to consult local authorities relative to use in that particular region. The directions for use may appear on the labeling accompanying the article.

If an economic poison is new or of unusual composition, it will usually be necessary, we think, to give more complete and definite directions for the uses for which the product is intended, since the user may have had no experience with the material and has no other advice on which to lean. The directions given should be as specific as possible and they should be sufficiently complete so that they are not liable to mislead the user. A statement to apply where weeds are found, for example, may not be adequate, since the user may not know the hazards involved when using the particular herbicide, neither will the statement "Kills insects" "Controls plant diseases" and "Kills

weeds" be adequate unless modified as to the specific kind or type of insects, plant diseases, or weeds. Warning and caution statements should indicate the dangers and clearly state the various hazards involved in the use of the economic poison.

We are interested in seeing that the labels on economic poisons are in proper form before they are marketed. The law provides that there shall be an ingredient statement on the front panel of the label. It shall give the name and percentage of each active ingredient together with the total percentage of the inert ingredients, or it may contain the name of each active ingredient, together with the names of each inert ingredient and the total percentage of the inert ingredients; The active and inert ingredients to be stated in descending order of percentages of each present. For herbicides containing 2,4-D, the active ingredients for liquids would be the true chemical salt, amine salt, or ester of the 2,4-D acid expressed in percentage by weight, with the equivalent of 2,4-D acid also given in percentage. The active ingredient of the 2,4-D powders are generally expressed in the percentage of 2,4-D acid.

Herbicide products that are highly toxic to man, like mercurial preparations containing 1% or more of metallic mercury, must bear on the label the word "Poison" in red, with skull and cross bones, and an antidote statement in language that is easily understood. A caution statement should appear on the label of many herbicides. It may contain a statement like, "Do not breathe dust or fumes; avoid prolonged or repeated contact with the skin; k ep away from children, pets, livestock and foodstuffs. Additional caution statements should be included with the directions for use on the label of products that are apt to cause injury to crop plants, flowers and shrubs. For example herbicides containing 2,4-D should contain such statements as:

(a) Do not apply on newly seeded lawns, bent grass or lawns containing clover.

(b) Do not contaminate irrigation ditches or water used for domestic purposes.

(c) Avoid drift of spray or dust onto susceptible vegetable and crop plants, flowers and shrubs. This is most essential where concentrated chemicals are applied by airplane or atomizing equipment.

(d) Adequate directions should be given for cleaning 2,4-D from the sprayer, hose and nozzle of the sprayer if it is to be used for other purposes.

Herbicide labels should contain names of weeds that the product is intended to kill. Usually some weeds are included that are harder to kill than others. Such labels should contain a statement to the effect that weeds hard to kill will require one or more repeat applications during the season.

Under the provisions of the act, the Government is empowered to proceed criminally against persons or firms shipping misbranded or adulterated economic poisons and misbranded devices in interstate commerce, manufacturing, selling, or offering for sale any such misbranded or adulterated articles in the District of Columbia or any of the territories. It further provides that all such

economic poison be registered with the U. S. Department of Agriculture. The Government is further empowered to seize any such misbranded or adulterated articles that are being transported from one State, Territory, or District to another for sale, or, having been transported, remain unsold, or in the original unbroken packages, as well as any such misbranded or adulterated articles which are manufactured, sold, or offered for sale in the District of Columbia, or any Territory of the United States. The act further authorizes the Government to exclude from the country any such adulterated or misbranded articles, or any such articles that are forbidden entry into, or forbidden to be sold or restricted in sale in the country in which they are made or from which they are exported, or any such articles which are otherwise dangerous to the health of the people of the United States.

I realize that in this talk you have not been given the answers to all the questions which have been raised by the new legislation. Frankly we do not have all the answers. Different problems are showing up every day and we are doing our best to solve them. We enlist the cooperation of the members of this Weed Control Conference in helping to maintain the highest standards possible in the increasing numbers and types of herbicides that are now being manufactured for public use.

STATE AND PROVINCIAL REPORTS OF NEW WEED ACTIVITIES

Dominion Experimental Farms - By: Geo. Knowles

During the year 1947 weed control experiments, involving the use of 2,4-D, were carried on at the Central Experimental Farm, Ottawa and on twenty Branch Experimental Farms throughout the Dominion of Canada.

The Uniform Plan of weed control experiments was followed in almost every instance. This work is allotted in such a way that all of the experiments outlined in this intensive plan are conducted at some point or other in Canada. In many instances the same project is conducted under the dry conditions of western Canada and also under the humid conditions of eastern Canada.

The most intensive weed control programme is in progress on those Experimental Farms located in the three Prairie Provinces. This is due to the fact that in these grain growing provinces weed control is a major agricultural problem.

British Columbia and the eastern provinces are rapidly becoming more weed control conscious. This is particularly true of Ontario, where there was formed this year a weed research committee composed of Provincial and Federal men employed in weed control.

Illinois - By: Charles Keltner

University of Illinois -- Contact with the farm population of this State has been through field days on the university farm where thousands of visitors have been told about weeds and weed control through culture and chemicals. Hundreds

of specimens of weeds have been received by the Agronomy Department and identified. Accompanying the identifications have been recommendations concerning the best control measures. At the Dixon Springs station in southern Illinois, over five thousand visitors received information on the mowing and the spraying of weeds. Weed control was also discussed at county pasture improvement meetings.

Department of Agriculture -- More specimens of weeds were submitted to this department for identification than in any previous similar period in the history of the same. When perennial weeds were received, the sender's attention was called to the importance of immediate control measures. Representatives of the Department of Agriculture cooperated with the extension service of the College of Agriculture in conducting connty weed control meetings; also in a series of county pasture improvement meetings.

Weed control was given proper consideration in the preparation of the Department of Agriculture exhibit for the state and county fairs. Additional attention to this subject was evident in the Department's exhibit at the International Livestock Exposition, Chicago.

The 65th General Assembly amended the state noxious weed law so as to provide counties with the authority to adopt noxious weed control programs and finance the same. In the same session, the Department of Agriculture was given the right to quarantine patches of Leafy spurge and Hoary cress. The legislature also limited the weed seed content of commercial feed mixtures and required that these seeds be de-vitalized.

Indiana - By: O. C. Lee

During the past two years a study was made of the weed situation in the State by a Weed Commission appointed by the Governor. This was done by holding a series of meetings throughout the State inviting Agricultural Leaders to attend for the purpose of obtaining their expression to see what they would like to have done in the State that might reduce weed losses. Most of the leaders were very definite as to their expression. They agreed that there are many weeds that are not only a threat on the farm on which they are found but to the entire community. They felt that in many cases the eradication of these weeds was beyond the means of the individual farmer. It was, therefore, apparent that the weed control job should be made a community enterprise with the individuals who benefitted from the clean-up to help support the cost of eradication. They were also very definite in stating that they are not interested in being compelled to eradicate weeds by a drastic weed law.

Following a summarization of these studies, the Commission wrote and presented to the General Assembly in 1947 a Weed Bill. The proposed bill would authorize groups of farmers within areas or districts to organize for the purpose of weed control. It specified that if a little more than half of the farmers requested the formation of such districts and make application through the State Weed Supervisor requesting same then they would have a hearing to discuss the pros and cons of the formation of such districts. A vote would be taken determining whether or not such a district should be created. This might be considered the mildest type of weed control law yet the Legislature did not see fit to pass this bill. No definite reasons for their decision were given.

Education to acquaint the landowners with the most practical and effective ways of eradicating weeds has gone a long ways towards putting these methods into practice. New developments in weed control, that of using chemicals, has greatly brightened the picture. We used to use sodium chlorate for the control of bindweed at a cost of $60.00 to $70.00 per acre. We are now suggesting that farmers plant bindweed-infested fields to corn and spray with 2,4-D at a cost of not to exceed $3.00 per acre. Not only is the cost approximately one-twentieth of that of sodium chlorate but makes it possible to produce a crop on the area while the weeds are being controlled. Likewise, wild garlic can be controlled in wheat fields by spraying with 2,4-D. I am using the word "control" because these chemicals are not one hundred percent effective in complete eradication but do hold weeds in check and it is evident that repeated treatments will eventually prove effective in eradication.

One of the big problems at present with the changing methods of control is that of designing and making available suitable equipment at a nominal cost to farmers. No doubt, the time will come when most farmers will consider a small sprayer as essential on the farm as cultivation equipment.

Spraying alone will not answer all of our weed problems, of course. An essential of keeping weeds out of the fields is that of clean seed to prevent the introduction and spread of serious weeds. Many seed companies have installed seed cleaning equipment, making it available to do custom work for farmers to remove dodder, buckhorn, Canada thistle, and other weed seeds. Another promising feature of weed control work in Indiana is the use of portable seed cleaning equipment mainly designed for the removal of weed seeds from wheat, oats and soybeans. This, like much of the spraying of weeds, is custom work done by some individual or organization who is interested in not only making a living for themselves but in doing something that will be of value to the farming community.

Iowa - By: E. P. Sylwester

Introduction

The Iowa weed control work is based primarily on education. However, the responsibility of the entire weed control program is divided into three distinct phases, namely regulatory, experimental, and educational. We might in a way of summary touch upon the responsibility of each phase and its accomplishments. In view of the shortage of time allotted to me, I am going to make this a very brief summary report even though I would like to discuss our weed control program with you to a much greater extent. The phases and responsibility of our weed control program in Iowa then are as follows.

1. Regulatory -- Our State Secretary of Agriculture, Mr. Linn, is our State Weed Commissioner. He is ably assisted in this work by Mr. Clyde Spry, who is attending this conference. In cases of serious complaints within counties or between counties, the State Department of Agriculture is called upon for regulatory measures. They are assisted in this respect by the Attorney General's office under the direction of Mr. Larson. Since the Iowa weed program is largely based on education, instances of serious complaints have not been too many. However, there are some every year. These, when they have arisen, have usually been settled to the satisfaction of all parties concerned. The State Department of Agriculture and Extension Service cooperate in holding

District Meetings for Supervisors, County Extension Directors, County Weed Commissioners, Custom Sprayer Operators, and farmers. This has been the custom in the past and will be expanded in the future. In January of 1948, we will have our first 2-day state-wide weed control meeting for County Extension Directors, County Boards of Supervisors, County Weed Commissioners, and Custom Sprayer Operators. This meeting will be jointly sponsored by the State Department of Agriculture and the Extension Service and will feature up-to-date methods of weed control plus equipment and chemical displays. A cooperative state weed bulletin prepared by the Extension Service and published by the State Department of Agriculture is in press at the present time and will be issued shortly.

The State Department of Agriculture also sponsors the State Seed Inspectors and Regulatory Seed Laboratory. The State Department of Agriculture Inspectors pick up hundreds of samples of seed every year and run purity and germination tests on them. They publish a report on their findings every year. This is Bulletin 97C and is published by the State Department of Agriculture in Des Moines. In 1946, their report covered 1,385 separate lots of seed. This report is available from the State Department of Agriculture upon request. The State Department of Agriculture in whom the regulatory weed and seed work is vested and the Iowa State College jointly also sponsor the Iowa Weed and Seed Council. A committee group composed of key farmers, seed dealers, Experiment Station workers, County Engineers, State Department of Agriculture members, County Boards of Supervisors, Extension Service, County Extension Directors, Highway Commission, Farm Bureau, newspaper, radio personnel, and others who are interested in better legislation and in enforcement and education in weed and seed control. Cooperation between all agencies, the State Department of Agriculture and the Iowa State College Agricultural Extension Service and Agricultural Experiment Station is excellent. Responsibilities thus divided are an asset rather than a detriment but cooperation is highly necessary to make any educational and enforcement program really effective.

2. Experimental -- Dr. A. L. Bakke of our Iowa Agricultural Experiment Station spends full time on and is responsible for the research work in weed control. Reports of his work are found elsewhere in the proceedings of this meeting. He has devoted a great deal of time to perfecting smother crop methods for weed control as well as to work with chemicals. At the present time, work on chemicals involving weed control is at an all-time high. Work is being done on noxious weed eradication on roadsides and in fields on selective spraying of small grains and flax using 2,4-D, selective sprays and Santobrite. Research is also going forward in weed control in vegetables involving such materials as Stoddart's solvents, Santobrite, and other chemicals. Preemergence spraying and mist application of chemicals is being studied. Land weed control programs have been well worked out. Work in all lines of weed control is being continued and expanded. We are short of personnel, both in research and Extension, but the program in the research field is moving along nicely and is really accomplishing results. These experimental results form the backbone of our regulatory work, resident teaching, and Extension teaching. Research work will be prosecuted more vigorously in the future than ever before because of the rapidly increasing knowledge in this field and because of the tremendous importance of weed control to agriculture.

3. Educational -- As mentioned before, the entire weed control program in Iowa is based on education. However, our last legislative session has amend-

ed our Weed Law to the extent that if it becomes necessary to enforce the provisions of the law, it can be done very easily. If such enforcement becomes necessary, the titled holder of the land bears this expense of eradication. The Weed Law provides for a County Weed Commissioner, for an enabling levy for weed control work, for an enabling levy for roadside brush control work, and for purchase of county-owned weed spraying equipment. The Weed Law enforcement in each individual county is up to the County Weed Commissioner, acting under the Board of Supervisors. The swing to County Weed Commissioners has been slow due to the absence of suitable personnel. Last year, approximately 50 counties operated under the County Weed Commissioner system. In counties where active weed control programs are in action enforcement has been necessary in only a few instances.

Because the entire Iowa weed program is based on education, enforcement is used only as a last resort. In an educational way, the specialist in the Agricultural Extension Service, working in the field of Botany and Plant Pathology, devoted full time to helping counties organize better weed control activities. There were individual weed meetings held in 45 counties. There were 42 days spent in state and district time at which time at Regional Field Days, most of our 99 counties secured additional help on weed control. In all, the specialist attended 183 meetings of all types, namely night schools, demonstrations, open county meetings, supervisory board meetings, etc. The total attendance at all weed control meetings was 18,201. There were 77 individual farm visits to problem areas, 18 radio talks on weeds, and 20 press articles on weed control. These latter articles are written up for newspaper use, but are also reworked by our Publicity Department for use in County Agent news releases and radio work. Five new leaflets on weed control were prepared. One cooperative bulletin with the State Department of Agriculture is in press at the present time and two reprints of our popular magazine entitled Farm Science were extensively used in meetings and correspondence to the extent of 40,000 copies of each reprint. There were 2,117 first-class letters written in response to inquiries concerning weed control. A kodachrome chemical weed control set of 150 slides was completed. Exhibits on weed control were sponsored at the State Fair, Dairy Cattle Congress, and by means of the Extension Caravan.

Never has interest in weed control been so high. Many hundreds of acres of oats, flax, and corn, were sprayed for weed control this year. Our most effective teaching method has been the demonstration type, where for 20 to 45 minutes on Field Days or at special meetings we demonstrated our small portable inexpensive sprayer. At such meetings, we also discussed smother crops. The swing in sentiment, however, is very definitely toward chemical weed control. Tractor attachment units are becoming extremely popular. In one county, there are now 50 such individually owned tractor units and in another county there are 200 where there wasn't one a single year ago. There are several companies in Iowa making these units at the present time. However, the surface has barely been scratched. We believe that as soon as these inexpensive trailer or tractor units become plentiful, they will be standard equipment on every farm. In addition, we have record of at least 375 Custom Sprayer Operators in Iowa now where two years ago, we had less than 50. The growth of individual home units and custom spraying has been phenomenal. We have two airplane companies doing aerial spraying work. Altogether, about 10,000 acres of pasture and corn land was sprayed for weed control by these two companies. About 50,000 additional acres of corn was sprayed with ground equipment by

mercial operators. No figures are available on individual amounts sprayed by individual farmers but thousands of acres were treated. Practically all of our counties now have some type of spraying equipment for roadsides, much of it modern equipment which was purchased this past season. The equipment bottleneck both for counties and for individual farmers is still critical. Most counties, however, will soon have modern spraying equipment. We feel that our program is finally functioning very well. We know that we are making very definite progress and capitalizing on the many years of educational work which we have promoted. Our progress has been largely due to the cooperation of all interested agencies. We believe that in the next two or three years we can make more progress in weed control in Iowa than what we have accomplished in the last 30 years. The chemicals and the smother crop methods which are now coming into very general use will serve to curb the tremendous losses which Iowa farmers have suffered every year because of weeds. We have every reason to believe that with the chemicals now at our disposal, we can make very serious inroads and very effective inroads on our weed problem throughout the entire state.

Kansas - By: J. L. Hutchison

The Kansas weed program during the past year has rolled along in about the same tempo as in previous years. There have been several changes of importance made to strengthen and improve the working parts of our weed program and thereby be of greater service to the people of our state.

1. Research Work in Kansas -- We will first pause to mention and to pay tribute to the excellent weed research work done in our state by Mr. F. L. Timmons, Agronomist, USDA at the Ft. Hays Experiment Station; Professor J. W. Zahnley at our state college and the work at our state weed experimental station at Canton by V. F. Bruns who during the year resigned to accept a position with U.S.D.A. under Mr. E. L. Kephart's corp of splendid research workers.

These men and their scholarly work is well known and highly recognized throughout the field of weed research and by most of you personally. Vernon Woesteneyer who is in attendance at this conference has taken over at the Canton Station and already has the work well in hand. Dr. Geo. McCall of the Du Pont Company has spent full time in Kansas during the past two years doing weed research cooperating closely with Professor Zahnley. We have enjoyed the fine cooperation from George and hope that the Du Pont Company will see fit to continue his work in our state indefinitely. Also the weed research fellowship by the Sherwin-Williams Company was used by Professor Zahnley of the Agronomy Department at our State College. In addition Mr. F. L. Timmons at Hays, Geo. McCall of Du Pont Company and Mr. H. E. (Skip) Meadows of the Sherwin-Williams Company, the noxious weeds division of the State Board of Agriculture and county weed set-ups are all working together in conducting some cooperative farm field tests scattered over the state. The primary purpose of these tests is to more widely and completely test the idea of combining the use of 2,4-D with tillage and cropping methods as a better means of eradicating large areas of the deep rooted perennial noxious weeds, such as bindweed. Preliminary results at Hays by Mr. Timmons indicate that such combi-

nations are much superior to the use of 2,4-D as a single and sole treatment for the eradication of such weeds. In Kansas 2,4-D by itself doesn't seem to get the job done with bindweed on an eradication basis. We are hopeful that large areas of bindweed can be eradicated by the use of 2,4-D when it is intelligently combined with cropping and tilling methods.

2. New State Law Regulating Herbicides - The last session of our state legislature passed a new law known as the agricultural chemical law, which is more commonly known in other states as an economic poison law. This statute regulates the proper labeling, registration and payment of a fee on all herbicides as well as insecticides, rodenticides, and fungicides. This law is in conformity with the federal economic poison act passed by the federal Congress during their last session. We feel this law is desirable for the proper labeling and sale of herbicides. We understand that South Dakota and North Carolina have also passed similar laws.

3. Changes in Chemical Use -- a. Borascu: During the current year we have legally approved borax in the form of borascu as an official weed killer for specific uses. Its use is officially limited to highways, railroads, irrigation and drainage ditches, petroleum installations, rocky places, waste land and other places where sterility is desirable or not objectionable, or where the soil is not used for plant production purposes. During the first year, our local weed programs have used in excess of 1,700 tons of borascu. This chemical was approved for the same use and as a substitute for salt which was used through the war period to supplement and to stretch the use of sodium chlorate. We feel that this chemical will prove better for its intended use than either sodium chlorate or 2,4-D.

b. 2,4-D: In Kansas we have officially and legally approved the use of 2,4-D for local weed programs for the treatment of bindweed and hoary cress when these weeds are found growing in a good stand of perennial sod grass. Since our state law officially covers only four of the deep rooted perennial noxious weeds, we feel that for the present we have gone as far as we can safely go on the use of 2,4-D, where public tax funds are used in paying a part of the chemical cost. We feel that 2,4-D is the very best method, and is being generally accepted by the public in our state, for the treatment of even the deep rooted perennial weeds which are susceptible when growing under the conditions mentioned. We hope that the weed research workers in our state can and will develop methods whereby 2,4-D can be recommended for wider use in the eradication of the worst weeds especially bindweed. A greater use of 2,4-D for the control of the commoner weeds is not a part of our state regulatory program and therefore must necessarily be handled by the existing educational agencies such as our extension service.

c. Sodium Chlorate: Sodium chlorate is still recognized and considered the best method for treating small infestations of any deeprooted perennial noxious weed when found growing on land which is devoted to crop production. Sodium chlorate will deliver that drastic knock-out treatment which most farmers want even at the expense of temporary soil sterility and much higher cost. Such treatment will immediately stop the enlargement of a small patch of perennial weeds which have a laterally spreading habit of growth, and with proper retreatment will eradicate the entire infestation. Kansas used about 2½ million pounds of sodium chlorate for this use during the past year and 18½ million pounds during the past ten years. It is our intention to continue on

this basis for 1948. It is our firm belief that sodium chlorate should be recognized as the best method of treatment under the conditions mentioned.

Legislative Improvements

The last session of our state legislature increased the state appropriation for noxious weed work to the extent of $10,000. This will make an annual noxious weed budget of $27,000 on the state level. The new funds appropriated were made for the following purposes.

1. For the employment of another assistant state weed supervisor who will devote his time in meeting with county, city and township officials for the purpose of working out yearly weed programs and to conduct annual weed inspection tours for county and city officials. Mr. Maynard Scott who has served ten years as county weed supervisor in Pawnee County has been employed to fill this important post.

2. For the purchase of decal labels which will be used for the tagging of all custom operated equipment in the state such as: combine harvesters, threshing machines, portable seed cleaners, field ensilage cutters and portable feed grinders.

3. For the purpose of employing extra help for a short period each year while custom combine harvesters coming from Oklahoma and Texas, move north and crossing our south line into Kansas. It is a well known fact that there is much bindweed just south of us, and it is also well known that combine harvester thresher is probably the most effective spreader of noxious weeds. For these reasons, it is our intention to develop an effective program for the cleaning of machines moving into the state as well as cleaning the machines as they move from farm to farm within the state. Each machine will be officially tagged with a state decal sticker which gives the provisions of the law and pertinent information on cleaning procedure. Anything that can be done to reduce the spread of noxious weeds at the source certainly is a most important phase of the weed problem and should not be overlooked.

Control of Spread -- Noxious Weeds

We desire to give a short report on the effectiveness of our program to reduce spread through the sale of feed material. All feed grains entering the state by commercial truckers are reported to county weed supervisors where the shipment is checked for noxious weed seeds, and if found infested the grain must be processed by grinding before being sold. From October 1, 1945, to October 1, 1947, a total of 1,773 truckloads involving over one million bushels or 5% were found to be infested and were processed by grinding before being sold or used. It is reported now that commercial truck operators are more careful in the purchase of their oats before hauling them across the line into Kansas. We are highly pleased on the operation of this phase of our program.

All feed oats destined for shipment to Kansas via railroad are inspected for noxious weed seeds by our state grain inspection department. If such shipments are found to be infested the shipment is not sold to a Kansas dealer but sold to buyers in some other state. Most of this work is done at Kansas City, and at ten branch offices scattered over our state. During the first two years

of this activity a total of 1,081 railway cars of feeding oats were inspected involving 2,162,000 bushels of grain of which 294 cars or 27.2 per cent involving 588,000 bushels were found to be infested with bindweed, and were sold elsewhere outside of Kansas.

In addition to these two activities our county supervisors also inspect feed grains offered for sale privately as advertised in local papers or when offered at public farm sales. Only recently we had a prosecution and fine assessed against a farmer and an auctioneer for selling bindweed infested oats at a public farm sale.

In this report we have attempted only to give new activities in our program during the past two years. We sincerely hope that state reports of regulatory weed eradication work will be considered a regular part of this conference program.

Manitoba - By: H. E. Wood

Activities of the Weeds Commission in the Province of Manitoba, Canada, that may be of interest to this Conference, include: an intensification of the campaign to eradicate deep-rooted persistent perennial weeds; assisting in furthering the use of 2,4-D for the control of weeds in field crops, and to eradicate woody plants; a survey of the handling and disposal of weed seed screenings.

Eradicating Deep-rooted Persistent Perennial Weeds

The campaign to eradicate deep-rooted persistent perennial weeds, chief of which is leafy spurge, has been intensified over the past two years. Eighteen weed control units under municipal management now look after spraying with Atlacide all small and scattered patches of weeds of this group, at no direct outlay to the farmer. Cost of applying and about 50% of the expenditure for chemical is borne by the municipality, the balance by the Province. Overall direction of this undertaking is given by the Weeds Commission.

The season just closed has seen a record amount of Atlacide used, 380,000 pounds on some 1,500 farms. In all 17,000 patches were treated. While costly, chemical is undoubtedly the most effective method of eradicating these weeds when found in relatively small patches.

Intensive cultivation for the eradication of leafy spurge and other weeds belonging to the deep-rooted persistent group described to this Conference a year ago, has been very considerably extended. In addition to an increase in the number of weed infested properties taken over and worked by municipalities, an increasing number of farmers are voluntarily adopting similar procedure. Under present prices, without exception, expenditures incurred for cultivation are being recovered as the land is cropped. Land unsaleable and a menace to the neighborhood before being taken over, after five years under municipal operation is becoming readily saleable at prices prevailing for improved land. By avoiding plowing and using almost entirely blade cultivators, and giving particular care to maintaining "trash cover" lighter soils are being brought under the plan, than were anticipated earlier. Cultivation, where care-

fully supervised and properly executed as a means of eradicating deeprooted perennials, has proven effective and economical.

Extending the Use of 2,4-D

Chief interest during 1947, centered in the use of 2,4-D to control weeds, especially annuals, in growing cereal crops. Extensive experimental work was conducted to determine the effectiveness of the several formulations at various concentrations which has been reported upon at this Conference. A 16-page popular bulletin "Chemical Weed Control", of which 51,000 copies were printed and distributed, was planned to give farmers and others using herbicides a better understanding of their place and correct use in the struggle to combat weeds.

The Manitoba Drainage Maintenance Board charged with the up-keep of several hundreds of miles of open drainage ditches in which willows are a very real menace was given assistance. A Buffalo turbine was used to treat about 100 miles (approximately 640 acres) of ditches, and proved a satisfactory type of machine for the job. Both an ester (butyl) and an amine salt were used as a spray at approximately 1-1/2 pounds acid in 20 imperial gals. water per acre. Excellent kills of willows were obtained, although it will not be until early summer 1948, that the true measure of eradication can be determined. Several municipalities used other types of spraying equipment at approximately the same concentrations, with gratifying results.

Weed Screenings Survey

Over the past year the Manitoba Weeds Commission has been concerned over the very considerable traffic in weed seed screenings. During the summer two surveys were conducted: one with the co-operation of elevator companies, the other through municipal weeds inspectors contacting farmers. The main purpose of these surveys was to determine if possible the potential menace screenings are in the over-all weed problem, and how best to regulate the disposal of screenings. Highlights of this survey were:

1. Spring wheat (1946-47, crop, Manitoba) carried 6.5% dockage.
2. About 80% country elevators clean grain -- mostly wheat -- about 35% cleaned.
3. One-third of the farmers take screenings home, with few exceptions in uncovered trucks.
4. Screenings not taken home are usually sold in carload lots (in bulk) or picked up by uncovered truck.
5. Screenings unsaleable are usually burned, sometimes dumped at the nuisance grounds.
6. Screenings from threshers (or combines) were reported disposed of as follows: fed, 70%; burned, 15%; sold, 10%; left on ground, 5%.
7. About one-third of the farmers stated screenings (or unclean grain) when moved by truck scattered weed seeds. They recommended care in making trucks "tight" and that they be covered.
8. A relatively few farmers will have nothing to do with screenings. As they come from threshers they are burned; those originating from cleaning at home are burned, crushed, or cooked before being fed.

Michigan - By: B. H. Grigsby

2,4-D Projects

1. Soil treatments

Pre-planting treatments of heavy applications of 2,4-D to destroy weed seeds in the soil. Studies are in progress on both mineral and muck soils and results obtained indicate that many annual weed seeds can be killed by this method. Certain species, however, are resistant. Results on muck lands are less satisfactory than on mineral soils.

Pre-emergence spraying of corn and potatoes has given promising results when the quantity of 2,4-D has not been excessive. Certain weed problems may become accentuated by this procedure but tillage operations can be altered to meet the changed problems.

2. Grain and corn spraying

Studies on the response of various varieties of corn, oats and barley to salts and esters of 2,4-D have been undertaken. Effects on yield and viability of grains produced by spraying at several stages of growth of the grain crops are being investigated.

3. Brush and woodlot weed control

Comparisons of 2,4-D with Ammate and borax for the control of woods vegetation in pastures, roadsides and ditch banks are being made. Results will not be available until next spring.

Effects of 2,4-D on various species of woody plants is being studied by the Forest Experiment Station.

4. Horticultural Crops

a. The effects of 2,4-D on strawberry varieties and growth habits of strawberry are being investigated. Rates up to 1# per acre are proving useful in the control of annual weeds.

b. 2,4-D is being used for weed control in asparagus. The asparagus plant appears tolerant of 2,4-D, at least at certain stages of growth.

c. A study of the response of sweet corn to direct spraying applications of 2,4-D has been undertaken. Tolerance of sweet corn to this chemical appears somewhat greater than that of field corn.

d. The tolerance of potatoes to light applications of 2,4-D led to an investigation of variety response in this crop. Formulation and variety of potato are important factors in this method of control.

Stoddard Solvent

1. The success of these products in carrot weeding has led to investigation of the material in an attempt to determine the effective fractions and to discover the tolerance of other crop plants.

2. Asparagus, when in full fern stage, has been sprayed with satisfactory results. Further study of methods of application is in progress.

3. Experimental spraying of transplanted celery has been undertaken to determine what factors contribute to the injury which is sometimes observed in this crop. Differences due to type and variety have been observed.

4. Preliminary tests of Stoddard solvent for control of annual weeds and grasses in blueberries have shown that at some stages of growth, the blueberry plant is tolerant of petroleum products. Further trials are proposed for 1948.

5. Some coniferous forest tree seedlings have been found to be tolerant of petroleum products. Further studies of species and age factors with respect to nursery seed bed spraying are being made.

6. A study of the effects of solvents on wild garlic is in progress.

Weed Grass Control

1. Quack grass -- Studies on the effect of iso-propyl-phenyl carbamate on quack grass have been made and further work along this line is in progress.

Research with ammonium trichloroacetate is being started on quack grass.

2. Crab grass -- Investigations with phenyl mercury acetate for crab grass control in lawns and turf were started in 1947.

Certain petroleum products have been found to have selective properties on crab grass. These materials are being tested for their effects on crop plants and an expanded program is planned for 1948.

Control of Water Weeds

A search for control measures for weeds in lakes and streams has been started. Special emphasis on the effects of weed control chemicals on other types of aquatic life will be part of this project.

Minnesota - By: T. L. Aamodt

You have heard considerable from the Minnesota delegation at this conference on the subject of Weed Research and Control. It is the expressed desire of the Minnesota organization interested in Weed research, regulatory,

control and extension work, that I, at this time, stress the organization of our overall cooperative weed work in the state of Minnesota.

Working closely together we have -- (1) The Weed and Seed Divisions, Bureau of Plant Industry, State Department of Agriculture, Dairy and Food. The Bureau of Plant Industry includes several closely related fields of pest control work in addition to the Weed Control Division, including the Seed Testing Laboratory, the Seed Inspection Division, Division of Orchard and Nursery Inspection, Division of Apiary Inspection, Division of Barberry Eradication, Division of Insect and Disease Control, and several special projects. (2) The Agronomy Division of the University of Minnesota. (3) Agricultural Botany and Physiology Sections of the Plant Pathology Division of University of Minnesota. (4) Agricultural Extension Division of the University, and (5) The Bureau of Plant Industry of the U. S. Department of Agriculture.

To coordinate and bring about continuous understanding of the functions and responsibilities of the weed workers in the state, the Minnesota Weed Committee was organized sometime ago which includes members of the various aforementioned organizations. In addition, the Weed Committee is also represented by the Soils Division, the Forestry Division, and more recently the Agricultural Engineering Division. Wherever possible each individual worker's responsibilities are defined and matters pertaining to each field are referred to the proper worker as they arrive. For example, taxonomic phases, ecology, growth habits of weeds, are referred to Professor A. H. Larson of Agricultural Botany. A. H. Larson is also a consulting botanist for the State Bureau of Plant Industry. General Extension demonstrations, etc., are referred to Mr. Ralph Crim, Extension Agronomist at the University. Fundamental physiological studies relating to weeds and research on the chemicals are referred to Dr. H. Heggeness, in Charge of Plant Physiology at the University Department of Agriculture. Agronomic phases of the weed problems; such as studies of cultural practices, crop successions, and field experiments with chemicals, residual effects of chemicals, etc., are turned over to Professor Ray Dunham of the Agronomy Division of the University. Weed control in vegetables is the responsibility of Dr. Victor Nylan of the Horticultural Division of the University. Federal weed research and control activities are referred to Dr. L. M. Stahler, Specialist and Collaborator with the Experiment Station for the U. S. Department of Agriculture. Dr. Stahler conducts the studies in chemical control and cultural practices for weed control, as well as carrying on studies in a number of other fields. Dr. Stahler works very closely with all agencies of the University and the State Bureau of Plant Industry. Matters pertaining to weed and seed regulatory control, as stipulated in the Weed and Seed Laws of the state, are referred to T. L. Aamodt, Director of the Bureau of Plant Industry, State Department of Agriculture, Dairy and Food. Control of woody plants, particularly the chemical control of woody plants, is of special interest to the Forestry Division as represented by Dr. Frank Kaufert. The Soils Division is represented by Dr. C. O. Rost and the Agricultural Engineering Division is represented by Professor A. J. Schwantes. It is obvious that coordination and understanding between all of these agencies is extremely important in order to have the job done. Professor Ray Dunham is Chairman of this Experiment Station Weed Committee and he is directly responsible to Dr. Harold Mach, Associate Director of the University Experiment Station. As often as is necessary, the powers that be

R. A. Trovatten, Commissioner of Agriculture and Dr. C. H. Bailey, Dean and Director of the University Agricultural Department and Experiment Station, are called into session with the Committee. Upon occasions other specialists or experts are called into the Committee in an advisory capacity. The Committee acts only in an advisory capacity and attempts to coordinate the efforts in order to get the most out of all the work carried on. Policies are determined by department and division heads. It is desirable we find to avoid unnecessary duplication, however, the position is not necessarily taken that all duplication is unnecessary.

I have received numerous inquiries from other states concerning the structure of the newly created Bureau of Plant Industry in the State Department of Agriculture of Minnesota. This will probably make as good a place as any to relay that information. All personnel, particularly division supervisors, of the State Bureau of Plant Industry work in close liasion whether the problem or responsibility is weeds, seeds, insects, disease, barberry eradication, rodent control or some special project. The personnel understands one another's problems and cooperate all along the way, particularly when dealing with special outbreaks of pests or newly established infestations of weeds.

There are three primary levels of this organization, as a whole; namely, the state level, the county level, and the township level. On the state level, we have the three division supervisors; Sig. Bjerken, Supervisor of Weed Control, O. A. Ulvin, Supervisor of Seed Inspection, Jack Larson, Supervisor of Seed Testing Laboratory. The full-time Agronomist is Dana Frear, and Professor A. H. Larson is consulting Botanist for the Weed and Seed Divisions of the Bureau of Plant Industry. A position has also been developed for a Weed and Seed Technologist, whose primary responsibility is to translate research into the regulatory and control fields. This recent development we feel is extremely important, keeping the control and regulatory procedures fundamentally and scientifically sound. As a full-time worker to maintain and keep township and county records, Mr. H. C. Hjortaas is an important part of the organization. Of course, the usual stenographic force is available in all of the divisions. Working directly out of the state office, we have established ten District Plant Industry Inspectors' positions whose duties are to carry out seed and weed inspection and control work in all of the counties of these respective districts. These men keep in constant touch with County Plant Industry Inspectors.

On the County level, we have (paid by the County) eighty-three County Weed and Seed Inspectors. This provides for a County Weed and Seed Inspector in all but four of the eighty-seven counties of the state. These men work under the direction of the state personnel and are appointed by law upon the recommendation of the Commissioner of Agriculture. There are a number of these men that are employed by the county for the full twelve months of the year. Many are employed primarily for the crop-growing season, however. We are striving toward a goal of twelve months employment per year for all of the County Plant Industry Inspectors. Several of our County Inspectors are present at these Topeka meetings this week. The employment of these County Plant Industry Inspectors is an extremely important cog in the wheel, providing responsibility directly to the local problems. These men work very closely with the county agricultural agents. It is obvious that this sort of an arrangement is ideal in view of the tremendous broad field for which the county agent is now accountable.

On the township level we have three township officers in each township who by law are equally responsible for weed inspection, law enforcement, and control. There are between five and six thousand of these men in somewhat less than two thousand organized townships in the state. In many cases the township officers hire a full or part-time inspector to carry on the work in the township such as inspection, serving of notices, etc. In cases of emergency we could well call these township and county officers "minute men". Thus we have the state, county and township weed control organizations completely tied together. In other words, we reach right down to the farm from the state level. In case of severe problems in any one county or township, we reach still further down to the establishment of section men who in turn work with the township officers. It is obvious that such an organization is of extreme value -- not only in weed and seed problems but also in general insect, disease and rodent control work. They are specialized workers in the counties and townships.

By law all of the township officers are required to attend meetings held in each county at least once each year for instructions, schooling, demonstrations, etc. These meetings start at 9:30 in the morning and carry on until 3:00 or 4:00 in the afternoon depending upon the importance of the pest problems in the particular county. Local problems are thusly dealt with. What we might emphasize in one county may be entirely different from what we might emphasize in another county in another part of the state. These meetings are carried on through the winter months usually by two or three teams of workers from the state office and of course district and county plant industry inspectors are also in attendance. Outside organizations are also invited to attend.

Well prepared illustrations and printed matter are supplied to these men at these meetings with full explanations. Particularly do we stress their responsibilities. We have always felt that the real fight against weeds is actually carried on during the winter months when contacts and planning is possible before the spring work starts on the farm. Weed control is taken into consideration when the crop rotations are planned. Unless the general farm outlay is planned during the winter months we often lose considerable time.

Once a year a weekly Short Course is held at University Farm by the university authorities in cooperation with state workers for all of the county and district Plant Industry workers. This is planned by Prof. Ray Dunham of the University Agronomy Division with the aid of a committee representing the various organizations involved. This year two days of this Short Course will be devoted to 2,4-D DDT and machinery. This two-day course will also include county agents, teachers of veterans, agricultural high school teachers, and others.

Many facilities of the state organization are made available in cooperating with university and federal research workers. For example one extremely valuable procedure in establishing and maintaining this cooperation is the power of the Commissioner of Agriculture to quarantine lands where there are infestations of primary noxious weeds and where eradication procedures may be set up at the expense of the state, county and township jointly in case the problem is beyond the ability of the owner to cope with. We have over one hundred of these farms and the control for eradication of the weeds is directly the responsibility of the state workers. Under such arrangements problem areas can be selected according to the needs of the demonstrations for research as desired. State and federal workers have made considerable use of such facili-

ties. Such activities tend to bring together extension, teaching, regulatory, research and control. It is obvious that all activities benefit by such arrangement.

It is important to point out that we have complete cooperation with the Federal Seed office located in Minneapolis. We are particularly fortunate in having excellent cooperation from this office in relation to inter-state violations of seed shipments.

Although all is not perfect we, I believe, are on the way to what may be termed a completely coordinated and effective weed and seed program in Minnesota. Very important is the fact that this State Bureau of Plant Industry of the State Department of Agriculture, Dairy and Food is housed at the University Farm campus where we are closely associated with research, teaching and extension activities of the University. Here we have some of the best reference libraries, herbarium, insect and disease collections in the country. We have continual association and reference with the research workers. With all of these agencies working so closely together -- continued consultations between regulatory, teaching, extension, control and research agencies there is little chance of going off "half cocked" in our procedures and recommendations. Necessarily lines must be drawn so far as designated responsibilities are concerned, but we just do not draw them too hard and fast.

I have been asked to say a few words about our recently enacted legislation providing for registration of pest-control aircraft operating in Minnesota. Under Chapter 560 -- Session Laws of 1947 an Act was passed to authorize the issuance of permits to owners and operators of aircraft used for the application of insecticides, weedicides, rodenticides and fungicides and imposing penalties for violations. The primary object of such legislation is to watch very carefully the activities of aircraft in this field. A number of reports have come to our office that dangerous drifting has occurred where herbicides have not been properly applied. Although the bill includes only aircraft a great deal of thought was given to the possibility of including ground machinery under the same provision. The following five points were considered by the Legislative committees when presented by members of the State Department of Agriculture, Dairy and Food.

1. The purpose and intent of this bill is to advise, guide, and instruct the operators of aircraft and high-powered ground machinery for the application of insecticides, weedicides, rodenticides, and fungicides (poisons and chemicals) in order to protect agricultural, horticultural, and conservation interests of the state. The use of aircraft and ground spraying machinery in the application of these materials will be very extensive in the future and will prove to be a boon to agriculture, conservation, and horticulture, provided the application of these materials is made with due regard to their potential dangers.

2. The dangers to crops from misapplication and overdosages of poisons and other chemicals include drift of dusts on to susceptible crops other than those being dusted, overdosages resulting in accumulation of poisons which may injure crops, kill fish, aquatic plants, and wild life, and the misapplication of poisons which could destroy bees and other pollinating insects.

3. Registration will enable the Department of Agriculture to learn the names and locations of all operators of these types of equipment and to furnish them with pertinent rules, regulations, and information which will enable them to avoid damage to crops, property and annual life.

4. Operators of aircraft and high-powered ground machinery for the application of poisons have appeared before Senate and House Committees supporting this bill. They recognize that it will enable this growing industry to establish itself on a sound foundation and so provide the maximum benefit to our agricultural and conservation interests in the state.

5. Farmers, agriculturists and horticulturists, together with conservation and public health interests fully supported this bill because it is realized that tremendous damage can be done in this state by uniformed or negligent spray operators. Withholding license to operate or the revocation of such license, together with suitable penalties, will require the operators take cognizance of recommended precautions for prevention of damage.

Missouri - By: Ross Fleetwood

Missouri, as most of you know, has a somewhat different weed problem than most of the states represented in this conference. The geographic location of the state is too far south for Canada thistle and quackgrass to be serious and the rainfall seems to be high enough to keep bindweed from being as serious as in the western states, but the southern part of the state is in the Johnson grass and Bermuda grass area.

As a result of this situation the problem of perennial weeds isn't as serious in Missouri as is the problem of annual weeds in cultivated crops and certain persistent weeds in meadows and pastures. Consequently there is no effective state weed control law and at present there seems to be no serious need of such a law. There is, however, a very good seed law which is administered by the State Department of Agriculture.

The experimental work on weed control is carried on by the Experiment Station of the College of Agriculture, while the educational phases are carried out by the Extension Service. At the present time no workers in research, Extension, or enforcement are designated to work solely on weed work -- the work being done by workers whose primary function is some other phase of agriculture.

During the past year the educational work on the use of 2,4-D was intensified and much interest has developed. A rather large acreage of corn will be treated with 2,4-D in 1948. Quite a number of counties have custom spray outfits and the number will increase in 1948.

Over 25,000 pounds of sodium chlorate were used on Johnson grass and bindweed, while some form of clean cultivation was practiced on over 9,000 acres of land during 1947.

Nebraska - By: Loys Smith

For the last three North Central Weed Control Conferences, Nebraska has reported on the state weed law and how it operates. There has been no change in the law. Today I wish to confine my statements to what has been accomplished in Nebraska since the conference at Des Moines last December.

The year, 1947, marks the tenth anniversary of Nebraska's organized fight against noxious weeds. As most of you know, our program is based on organized weed districts. Last year at this time there were 69 weed districts in the state; today, there are 87, most of which are on a county-wide basis. A few of these districts were organized too late for an active weed program this year but will be ready for an early start next spring.

The facts and figures I propose to give are based on the 82 weed districts that were actively engaged in weed work this year. There were about ten carloads of sodium chlorate and atlacide used in the state. We still feel there is a place for sodium chlorate chemicals in our weed program. Very few are using clean cultivation or duckfooting as a means of controlling their noxious weeds.

For the most part, the weed districts are using 2,4-D and other weed killing chemicals as a means of controlling their weeds. There were 100 district-owned sprayers in operation last year and sprayed about 30,000 acres of bindweed and other noxious weeds.

The weather conditions last spring were very unfavorable for spraying, but when the work started, there were more requests for spraying than the districts could take care of. About 40 commercially-owned sprayers relieved the situation by spraying about 10,000 acres. District supervisors encouraged farmers to own and operate their own outfits and supplement the efforts of the weed districts. At the beginning of the year, there were only 24 such sprayers in the state but before the spraying season was over, the number had increased to 250 individually-owned machines which treated approximately 25,000 acres. 125 of these machines are in one district. There were no 100% kills but farmers were generally satisfied. The reported kills ranged between 50 and 99 per cent. Railroad, state and county officials cooperated by treating their weeds or having weed districts do it for them.

Weeds other than our six noxious weeds were treated. An estimated 50,000 or more acres of corn and other crops were treated with 2,4-D for control of weeds such as cockleburs, sunflowers, pigweeds, velvetleaf and bindweed. Of this acreage, about 1,800 acres were treated by airplane. There is considerable interest in the destruction of the weeds poisonous to livestock in the range areas; also those causing hay fever and skin irritation to humans.

For a program of this magnitude to operate efficiently and effectively, there is need for plenty of spraying equipment and chemicals. In order to bring the equipment and chemical dealers and the weed supervisors together, the Division of Noxious Weeds cooperating with the College of Agriculture sponsored a state weed conference, chemical and equipment show last January. The response was very gratifying. With spraying equipment and chemicals on display, the supervisors were given an opportunity to make purchases best

suited for their conditions and needs. About 500 people were in attendance. A similar meeting will be held again January 8-9, 1948. With the increased number of weed districts organized, more weed supervisors should be in attendance. Following this meeting, each district will hold its annual landowners meeting during the first quarter of the year. Later in the spring, six or eight regional meetings will be held over the state by weed specialists, thus giving the local weed supervisors, district managers, and equipment operators a chance to learn the latest information on weed control.

A number of you heard Mr. Hanson discuss the topic "Weed Control Week" on the program last year.

Another weed activity being undertaken in Nebraska is not "Weed Control Week" as was discussed at our conference in Des Moines last year, but a "Nebraska War on Weeds campaign. This program is designed to supplement the activities of the Division of Noxious Weeds. The aims of this program are (1) to acquaint the citizens of the state with the seriousness of the weed situation and make everyone more weed conscious; and (2), to disseminate through press and radio timely information on weed control. A "War on Weeds" Board was set up with the Governor as honorary chairman. Then an Executive Board, was created with the director of Extension as chairman. In addition, the organization includes Advisory, Technical, Finance, and Public Information Divisions. The program has been set up with educational and recognition features. Educational features include courses of study in public schools, the encouragement of individuals to make weed collections, reorganization of weed 4-H clubs, and identification contests. Recognition of farmers and municipalities that do outstanding work in weed control is planned. It is very encouraging how educational, agricultural, and civic organizations of the state are responding to the idea.

In closing, I want to say that we are pleased with the cooperation we have received from the farmers and all others interested in the weed program. The 2,4-D chemicals and other weed killing chemicals are not 100% effective in one application. Farmers do not expect it. Without a doubt, these chemicals will be extensively used in Nebraska next year, not only on noxious weeds but weeds in growing crops, roadsides, fence rows and waste places.

North Dakota - By: Lars Jensen

The addition of a half-time weed research man to our station staff has enabled us to expand fundamental work on the control of weeds. Specifically, these projects are new studies on seed germination, (2) factors affecting competition between weeds and economic crops with and without the interference of selective herbicides, (3) the effects of time of application, rate, volume and formulation of 2,4-D on varieties of spring wheat, (4) the value of certain newer chemicals for control of weedy grasses, and (5) the physiological reactions of crops and weeds to 2,4-D. These projects are now in progress.

Educational activities have included the publication of two circulars. One on weed control with 2,4-D and one on an inexpensive and effective home made sprayer. All county agents have carried on active educational programs. Plans have been made to expand demonstrations next summer on weed control by

2,4-D in areas where this chemical has not as yet been widely used and to carry on a state wide program to encourage individual farmers where practical to obtain equipment for the application of herbicides. Most of the county agents carried on some spraying demonstrations the past summer to familiarize themselves with the newer materials.

I am not in a position to report on regulatory phases of weed work in our State. We have no operating state weed control law except as it pertains to the distribution of crops for seed.

Oklahoma - By: Clyle Bower

The report for the State of Oklahoma can be called a Progress Report. During the past year an increasing number of our farmers in the wheat belt have applied 2,4-D for the control of bindweed. In no case has it given eradication but it promises to fit into the scheme of other control measures which are also practiced. For the first time in several years some of our farmers were able to obtain a wheat crop even though reduced somewhat in yield from land which for several years has been solid bindweed.

There is also more activity in our state relative to the control of various types of brush. During the past year several chemical compounds were applied to several hundred acres on an experimental basis. In our state this too promises to be of value when the details are worked out. We are still greatly interested in chemicals for the control of Johnson grass and are glad to know of a little additional activity in that field. During the past year dozens of the several hundred sprayers used for spraying livestock have been used for weed control and we are confident that it will develop much faster in the future.

Saskatchewan - By: T. K. Pavlychenko

Saskatchewan is the largest grain growing province in Canada. Grain farming, which is only approximately 65 years old, is by far the most important industry of the people. The weed problem of the province is correspondingly great.

There are three distinct periods in this short history of our Agriculture with respect to the weed problem. Until 1929 the people followed what may be called a "good neighbor policy" toward the weeds. They lived with them. By that time the "neighbor" proved to be a bad one and the people got angry. In that year the province, and later the National Research Council of Canada, started a comprehensive weed research program. This marked the beginning of the second period. From 1929 until the present time much work has been carried out and the results obtained have been used in practical weed control and for the educational purposes. As a result, the weed problem was considerably explained with respect to its economical significance as well as the technical possibilities of handling it under existing conditions. General supervision of the field weed work was resting with the Field Crops Branch of the Provincial Department of Agriculture, but no permanent body was ever designated to

consolidate the research, educational and administrative efforts in this field until 1946.

From this year the third period has begun. It may be called a period of consolidation. It was marked with the establishment of the Saskatchewan Advisory Weed Council, which is a permanent body, Advisory to the Minister of Agriculture. It consists of representatives of several Departments of the Provincial Government, the University of Saskatchewan, the Dominion Experimental Farms, and the most important provincial farm organizations. Its purpose is to study the weed problem as a whole, to outline projects in the field of weed research and education, and then to advise the Minister of Agriculture with respect to the general policy on the problem.

It may be mentioned that on the advice of the Council the Department of Agriculture is already planning to establish a position of a full time weed specialist in the Province.

The Council also adopted a resolution in 1947 that the University of Saskatchewan be approached to enlarge its courses on weeds for students of the College of Agriculture in order to provide a fully trained personnel in this field.

The Council further suggested that each Experimental Farm in the Province undertakes a long term project on perennial weeds, which are most important to their respective districts.

Another important step which was undertaken by the Department of Agriculture in this period is the organization of the Agricultural District Boards. These are intended to deal with the pressing agricultural needs of their districts. The local weed problems thus come under their close consideration.

The third step of very great practical importance was the reorganization of the technical agronomic service in the province. The Agricultural Field Representatives, who until 1946 were attached to the Field Crops Branch, became a separate Branch of the Department of Agriculture.

It is hoped that under the new setup both within the Department and in the Province, it will be possible to develop a fully effective action program in the field of weed research, public education and administration of the work of weed control.

With regard to the general weed situation in the province, it may be said that annual weeds, particularly wild mustard, French weed and Russian thistle, are so prevalent that, if not controlled in a growing crop, they depress the yield at least 10 to 25 percent annually. On account of these and other annual weeds the production of flax becomes an uncertain business.

The perennial weeds, although less prevalent and economically less significant, are quite bad in certain districts.

Chemical weed control was applied on both annual and perennial weeds on a very considerable scale during the last two years with gratifying results in most cases. It is particularly important to mention that in 1947 sufficient field trials were made to control the annual weeds in flax which indicated

that both the dinitro and 2,4-D compounds may be safely used for that crop. This is of special importance to us since it revives a new hope of developing a substantial linseed oil industry in the province.

South Dakota - By: W. L. Klatt

The South Dakota weed control program is comparatively new, since the weed law was enacted in 1945 and amended in 1947. The program is administered by a State Weed Board, consisting of nine members, who represent officials and public service organizations directly concerned with weed control. The members of the Board are: the State Secretary of Agriculture, the President of the Crop Improvement Association, the President of the State Horiticultural Society, the Chairman of the Association of Soil Conservation District Supervisors, the Director of the South Dakota Extension Service, the Head of the Agronomy Department of South Dakota State College, the Commissioner of School and Public Lands, and one of the State Highway Commission, designated by the Governor. It can readily be seen that the program is conducted by state organizations and that it is very closely coordinated with their activities.

The State Weed Board is vested with the power to formulate and to administer the state weed control program. It may make rules and regulations to effectively carry out its policies and to prevent the spread and to provide for the control and eradication of noxious or dangerous weeds. The State Weed Supervisor and an Associate are appointed by the Board to carry out the policies and administer the program. The program, which is based on research, education, action and enforcement is coordinated and financed through funds appropriated to the State Weed Board. Education and publicity is handled by the Extension Service, Research is carried on by the Experiment Station, Enforcement of the Rules and Regulations of the Board is handled by the State Department of Agriculture,and the State Weed Supervisor is charged with the administration of the state weed program. The legislature appropriated a sum of $104,700 for the biennium 1947-49 to the State Weed Board for these activities.

The county weed programs, as established, are thoroughly democratic. Weed control has long been recognized as a community problem, and as such, requires the cooperation and unified action of individuals in a community, so that every farmer and every piece of land will be a part of the program. Through the cooperation of the Extension Service, meetings were conducted to explain the weed program in all communities in the counties where the program was initiated. Farmers, in the community meetings, elected representatives to a county meeting, where a County Weed Board of three members are elected.

The County Weed Board, in cooperation with the County Commissioners, the County Extension Service, and the community weed representatives determine the most practical program to be adopted for the county. Every effort is made toward getting a complete and effective county-wide organization. Weed leaders are selected in each community to complete a weed survey and to enlist active participation in the program. Many farmers and groups of farmers have already secured their equipment and are cooperating. In a number of counties weed supervisors have been employed to assist the County Weed Boards in carrying out the program.

The South Dakota Extension Service is taking an active part in the organization activities and in conducting the educational phases of the program. Two hundred and seventy weed meetings were held throughout the state with an attendance of 8,500. To date 45 counties have elected County Weed Boards and have organized county weed programs in action. Every county in South Dakota having a county agent, of which there are fifty, received a war surplus sprayer. This equipment was used for demonstrations both in fields and on road sides. These educational activities have been most important in getting the county weed programs underway.

Boards of County Commissioners and other governing bodies of cities, towns and townships are authorized to appropriate funds for weed control. No tax may be levied until the county has been organized in accordance with the program adopted by the state Weed Board. The tax levy shall not exceed one mill on all taxable property within such governmental subdivision. Thirty-two counties made appropriations totaling $130,000 for the administration of their programs in 1948.

Enforcement provisions of the state weed law and rules and regulations of the State Weed Board are carried out by the Department of Agriculture. During itinerant combine season, July 24 to August 20, a total of 5,445 harvest vehicles, including 1,726 trucks and 3,710 combines were inspected, cleared, tagged and recorded in the office of the Secretary of Agriculture. Inspection activities are also conducted with elevators, feed and seed houses to secure cooperation in preventing the further spread of weeds.

Adequate provisions for research have been included in the program. Two men are working full time on weed research in addition to a close cooperation with the Bureau of Plant Industry, Soils and Agricultural Engineering. Extensive trials, both cultural and chemical, are being conducted on the weed control Research Farm located near Scotland. Attempts are being made to determine how herbicides can best be used in a bindweed control program and the use of crops is being studied to determine which cropping practices are best suited to elimination of bindweed and the prevention of reinfestation. The use of perennial grasses is being studied, with respect to their ability to control bindweed in western South Dakota. Extensive tests are being made on the use of herbicides on other noxious weeds and annual weeds.

The South Dakota program is in the development stage, so no information can be presented as to the amount of actual control and eradication work that has been done. South Dakota is weed conscious and with the interest and cooperation that is being evidenced, the weed control program should develop rapidly.

Wisconsin - By: K. P. Buchholtz

The Wisconsin weed control program is carried on by the State Department of Agriculture through the Seed and Weed Division and a part time extension man in the Agronomy Department. Research is carried on by Dr. Buchholtz and Dr. Warren at the Agricultural Experiment Station at Madison and field tests at the branch experiment stations.

Increased emphasis has been given the weed control program this 1947 season, through radio programs twice monthly through growing season on "Keeping up to the weed front" also by six broadcasts by the Seed and Weed Division of the State Department of Agriculture on the responsibility of weed control officials, with emphasis on "what local communities and counties are doing and can do in organizing for effective weed control.

Most of the county agents' programs had weed control listed for 1947. These programs varied, depending upon the newness of the activity, the extent that interest should be solicited, and leadership already shown in various communities. Some of the means for putting on effective weed control programs are listed below.

1. Through meetings such as county agent committee, special highway department committee, with county boards, with special committee selected by county agent representing all agencies interested in rural advancement, with county weed commissioners, with officers and/or members of farmers organization with farmers within township, and general meetings called specially for weed control or in a general farmers meeting as farmers institute.

2. Demonstrations of equipment and discussion on same and materials at county and regional grassland field days -- where 3000 to 8000 farmers attend at each place.

Some of the accomplishments are enumerated:

Many special meetings and exhibits of spray equipment -- by operators and distributors.

Township and Highway Departments purchase of spraying equipment and materials.

Demonstrations of weed control on certain roads within county.

More and more custom spray outfits being available for use.

More and more home made and purchased small spray equipment for individuals used privately or cooperatively.

Support by counties given to townships and Smith-Hughes agricultural teachers in purchasing materials and equipment for demonstration purposes.

Partial cost of application by town boards.

Two counties with weed commissioners and deputies in each township.

Provision in AAA program for 2,4-D dinitro and quack grass mechanical control.

More definite stand on weed control by farm publications.

Report of First Western Canadian Weed Conference Held in Regina, Saskatchewan November 26-28, 1947

By: H. E. Wood - Manitoba

As it was not possible for your President or Secretary to attend this gathering, President Hanson asked me to represent the N.C.S.W.C.C., which I was happy to do. Attendance exceeded expectations in that 142 delegates registered, twelve from the United States, and from as far east as New York and Washington, D.C. Attendance was about equally representative from Universities, Dominion and Provincial Departments of Agriculture; as from chemical, machinery and grain handling organizations.

The Conference had two main objectives: (1) pooling of results obtained to date with 2,4-D, and laying plans for the year to follow. (2) to "spotlight" the perplexing problem of weed eradication and control through the Prairie grain growing area. I am happy to report that in addition to appearing to have accomplished much along these lines, the meetings afforded an excellent opportunity of workers among themselves, and with company representatives, to become better acquainted.

Some time was given over to discussing progress made over the last several years in the three Prairie Provinces in the control, mostly under municipal-governmental action, of deep rooted persistent perennials. Following success with chemical--sodium chlorate--for the smaller infestations, cultural and special cropping procedures were reported as bringing results where infestations are more extensive. The problem of weed screenings was aired, Manitoba reporting upon a survey just completed which showed the movement of screenings to be a potential source of weed infestation.

Committees prepared, and the meeting endorsed, recommended amounts of 2,4-D acid to use on various crops according to formulation. Flax was included as a crop on which 2,4-D could be used provided dosages were scaled down somewhat. A list of weeds according to susceptibility was prepared.

The conference went on record as favoring a similar gathering in 1948.

Report of Western Weed Control Conference

By: Walter S. Ball - California

Friends of the North Central Weed Control Conference, I wish to state again that it is indeed a pleasure for me to meet with you and discuss the weed problems of the north central and western states and report to you the activities of our Conference which was held last February.

I wish to thank Mr. Hanson and Mr. Ted Yost for their kind invitation to come to Topeka. I feel that representatives from our Conferences mean a great deal, as I can say sincerely Mr. Hanson's and Mr. Klatt's visit with us in Portland was certainly worthwhile. There were many problems which arose relative to weed control and Mr. Hanson assisted greatly in giving us a much broader view of the over-all picture, since the conditions in your area are different from those in the far west. Mr. Hanson also gave us a very complete

report of your meeting held in Des Moines last year and brought out many points worthy of our consideration.

Our meeting last year, as already mentioned, was held in Portland February 6 and 7, and it was the best attended meeting we have had. Inasmuch as we have only the eleven western states, and of those only nine that are active, we do not have the representation and consequently do not expect as large a gathering as you have at your Conference. It was very gratifying, however, to have a total of some 240 attending our first day's meeting. It surely points out the contrast of the first four or five meetings that were held by the Western Weed Control Conference, when we were exceedingly fortunate in getting 40 or 50 persons to attend. It is needless for me to mention the extreme interest in weed control over the past few years, as all of us are too familiar with this problem and we are all trying very hard to keep up with it.

There has always been much interest shown at our Conference in the reports of the various states, which are usually given the first day of our meetings. Some comments have been made relative to the importance of such reports, due to repetition, but we have found generally that on account of the great variety of conditions which we have in the West, having a portion of the plains area, the mountainous areas, of high elevation, and the coastal areas as well as the desert, many interesting features of weed control are introduced which lead to very interesting discussions. Most of the weeds of primary importance are found in our western states, which gives us a very broad over-all picture of weed control.

Following the reports of the states, which included that of Canada as well as the already mentioned report of Mr. Hanson, we had a very interesting paper presented by Dr. E. O. Essig, Head, Division of Entomology and Parasitology, University of California, Berkeley. This paper dealt with those insects which have proved to be detrimental to agriculture and in many cases have caused thousands of dollars in crop losses. Dr. Essig pointed out that in most of these cases, or practically all of them, if it were possible to control waste-place plant growth, that the insect damage could be curtailed to a very high degree. One very important problem in the West is the control of the lygus bug, the most important pest of the alfalfa seed industry. These insects breed up in great numbers in uncultivated waste land and continuously migrate in alfalfa fields where they destroy the blossom. They also infest beans, cotton and other crops. He also mentioned certain insects that, through control of their favored weed hosts, have been practically eliminated insofar as their economic importance as a pest is concerned. He mentioned the fact that in some cases insects had proved beneficial in weed control programs and referred especially to the control of St. Johnswort (hypericum perforatum) for which insects have been imported from Australia. This program is now under way in California and I understand other states will be included.

Following this we had a report from Mr. H. R. Offord, U. S. Department of Agriculture, Agricultural Research Administration, Bureau of Entomology and Plant Quarantine, who spoke on the Control of Weed Hosts and Plant Diseases. This, too, proved to be very interesting, showing the importance of weeds where they occur as hosts for disease organisms and as insects cause heavy losses to the agricultural industry throughout the United States.

Mr. Robert B. Balcom of the Bureau of Reclamation, whom you all know, gave

us a very complete report of the work of the Bureau in weed control, which was of much interest to us in the West due to the fact that they have a very extensive program closely related to our irrigated farming. He told of the cooperation of this Bureau and the Bureau of Plant Industry and the work they are planning to carry on. Mr. Balcom has met with us at most of our meetings in recent years, and we look upon him as we do Mr. Kephart, as one of us. We hope they will find it possible to continue meeting with us inasmuch as they are in a position to give us information relative to the activities of officials from the various parts of the United States.

Mr. Kephart followed Mr. Balcom and gave a very short but snappy talk, right to the point, ending with this comment, "Weed control is out of the horse and buggy stage and is now big-league stuff". And I think all of you will agree that those few words cover the situation very well.

Cecil Tapp of Canada, who was at our meeting primarily to attend the Seed Officials' meeting which preceded our meeting, was kind enough to talk to us relative to some of the weed control problems of Canada as he saw them from the seed angle, which was very interesting.

Dr. Robbins presented a paper on Weed Control of the 1700-Acre College Farm and in this he presented a well organized weed control program, taking in all of the various phases of weed control which might be incurred on any farm of that size or smaller.

One of our most interesting discussions at the meeting, I felt, and the response of the group, I believe, verified my thoughts, was the round-table discussion on the Respective Merits of Chemical Control and Cultural Control. Dr. D. D. Hill, Department of Farm Crops, Oregon State College, L. E. Harris, Chipman Chemical Company, and C. E. Seely, Associate Agronomist, Weed Investigations, University of Idaho, and R. N. Raynor, Dow Chemical Company, Pittsburg, California, covered this field very effectively, and instilled so much enthusiasm in the group that it was necessary for the chairman to call time in order to get on with the program.

A subject which has been of interest to many of us in the West, inasmuch as soil fumigants have been used rather extensively, was a paper by Virgil Freed, Assistant Agronomist and Chemist, In Charge of Weed Investigations, Oregon State College. Mr. Freed covered this subject from the research viewpoint and did a very splendid job of it. It was so well presented, and a most interesting paper. Mr. Freed talked primarily on the new material, "D. D." To summarize Mr. Freed's paper very briefly, he stated that he used dosages of D. D. ranging from 300 to 600 pounds an acre at 15-inch intervals, two inches deep, and secured anywhere from 80 to 100% control of Quackgrass. He stated further that wherever the control of Quackgrass drops below 95% it usually could be attributed to the soil being too dry or the injections being too far apart or too deep. Most of the work done on Quackgrass was done on a sandy loam type of soil. He also stated that when properly applied, a 100% control was secured on Canada thistle, Morning-glory, White top and Russian Knapweed. He stated that on these four plants the injections should be anywhere from four to six inches deep, preferably four inches, and at one-foot intervals. The reason we are favorably impressed with this material, Mr. Freed states, is

the fact that it can be used under a wide variety of conditions, more so than any soil fumigant heretofore tested.

Another high light of our meeting at Portland was a panel discussion, led by Chet Otis, on Weed Control Equipment. The panel members were F. E. Price, formerly Head of the Agricultural Engineering Department of Oregon, W. A. Harvey, Department of Botany, University of California, Davis, and R. N. Raynor of the Dow Chemical Company. This discussion was very interesting and brought about many of the necessary changes which will probably be found essential in handling spray materials and dusts and especially at low volume and low pressure. The airplane phase of this was discussed by Mr. Harvey who had a number of slides showing application of herbicides by airplane. This discussion, too, ran over time due to the extreme interest in this subject.

Mr. R. S. Bessee, Assistant Director of the Oregon Experiment Station, discussed the Hope-Flannegan Act (Public Law 733). With the use of a well organized chart he clarified many points relative to the Act for those interested.

We were very fortunate in having Mr. A. G. Norman, Chief of the Chemical Division, Chemical Corps, Camp Detrick, Frederick, Maryland, on our program. Mr. Norman gave us a paper on the Synthetic Regulators as Herbicides. His discussion was very interesting and instructive, giving us the development and history of the growth regulators and bringing us up to date insofar as his work was concerned. There were, of course, many questions from the floor regarding the practical phase, and a general discussion followed which brought out a very important angle of the 2,4-D picture, that of practical application. Various research workers became involved in specific problems having to do with temperatures and other factors which may have had a bearing on results. The general conclusions being that we still have a great deal to learn on growth regulators as herbicides.

Inasmuch as we had had some publicity on the compound, carbamate, Dr. R. W. Allard, Agronomy Division of the University of California was invited to give a paper on the effect of certain growth regulating compounds on grasses. In summarizing his paper, he mentioned the fact that carbamate has proved much more toxic on some grasses than 2,4-D and this has been particularly true of the less important grassy weeds. On other grasses it has proved very resistant, including Johnson grass and water grass. Most of the dicotyledonous plants so far tested have been unaffected by rates of application which stunt or kill susceptible grasses. The tomato has proved an exception. Further work, he states, is necessary to determine the plants which carbamate does and does not effect. He infers that although the compound has received considerable publicity for grasses, at the present time evidence indicates that its place as a weed killer is not too promising.

Following the discussion of this paper, Mr. W. A. Harvey presented the report of the Research Committee, which was followed by committee reports, resolutions, and the election of officers. The officers elected were: Virgil Freed, President; Bruce Thornton, Vice-President, and Walter Ball, Secretary-Treasurer.

Copies of the proceedings of our Portland meeting are available should any of you be interested in requesting them.

I would like at this time to invite all of you to meet with us at our next Western Weed Control Conference which is being held in Sacramento, California, February 2, 3, and 4, 1948. We are planning on a rather rounded out program of general interest in weed control. February 3 the Conference will move to the University Farm, University of California, Davis, where the day will be spent featuring equipment, spray materials, and especially stressing nozzles, and various demonstrations.

This, Mr. Chairman, completes my report of the Western Weed Control Conference, and with your permission I would like to mention briefly some of the work being carried on in California.

The major part of our weed control work last year was confined to selective spraying, which falls in three general categories, that of selective weed control in grain fields, in rice, and truck crops. A greater percentage of the acreage of these crops was sprayed for weed control last year, and in the case of rice and grains, the yield in many instances was increased 50%. Generally speaking, results with the use of 2,4-D for weed control in grain throughout the State have been very satisfactory and we have found through field tests at Madera, California, that with favorable conditions followed by proper applications, the yield of grain could be increased as much as four times. It was found quite generally throughout the State, that dissatisfaction insofar as results were concerned, could be traced to the fact that sub-lethal doses were applied or the application was made during unfavorable atmospheric conditions. Field tests were run on low volume application, with airplanes, in an attempt to find droplet dispersion and results. This was done by placing glass slides on test plots in an effort to obtain the number of droplets for a given area. With the equipment used for these tests, the 10-gallon rate gave 400 droplets per square inch; 7½ gallons, 300 droplets per square inch; 5 gallons, 144 droplets per square inch, and 3 gallons, 76 droplets per square inch. On the plot in which 12 ounces of 2,4-D acid and 10 gallons of water were applied, the results were best. This, of course, was merely a field observation in order to get some idea of the actual coverage on plants with a known amount of material by airplane application.

In the case of rice, the results generally were very good where again the proper dosage was applied. Inferior results were found to be the result of sub-lethal doses of 2,4-D.

There is very little to be added on the truck crop selective program, as it has been reported on from time to time and has proved practical and economical.

There are two new features of weed control in which we are very much interested and which are proving very satisfactory, the first, pre-emergence spraying, and if you will recall the past meetings, I have reported preliminary observations in this method of weed control. The work carried on this past year at both the Experiment Station and in field practice has proved very promising, having been conducted primarily in sugar beets. In some of our sugar beet lands the water grass had become one of the most serious weed pests and very little had been worked out to satisfactorily handle this particular problem. To briefly summarize some of this work, I would like to quote from a paper by Professor W. W. Robbins, and Professor Roy Bainer of the College of Agriculture, University of California.

"Pre-emergence Spraying to Control Weeds in Sugar Beets. The field tests were as follows: In December the field was disked and floated; a portion of the area was left flat, the remainder ridged and formed into beds; the field was left in this condition throughout the winter; seedings to sugar beets were on February 24 and March 12. At the time of seeding there was a good growth of various winter weeds, mostly in the seedling stage. Decorticated sugar beet seed was drilled in at three different depths: 1 inch, 1¼ inches, and 2 inches. A precision drill was used, the seeding rates ranging from 4 to 5 pounds per acre.

"There was no disturbance of the soil prior to seeding; the seed was drilled through the weeds. This point is worthy of emphasis. It is known that with most weed species only those seeds germinate which are within the upper 1/4 to 1/2 inch of soil. If, as is the usual practice, the first crop of weed seedlings is destroyed by cultivation, the stirring of the soil brings more weed seeds near the surface and soon another crop of weeds appears. Prior to emergence of the sugar beet seedlings, the entire plot area was sprayed with several different general contact weed killers.

"All treatments were applied at the rate of 50 gallons per acre, except numbers 1, 2, and 7, which received 30 gallons per acre. The results may be summarized as follows:

1. All applications gave a satisfactory weed kill.

2. The rate of kill was more rapid in the case of those sprays which were "fortified" with either Dow General, sulphur, or pentachlorophenol; and, the rate of kill increased with an increase in the amount of oil the mixture contained.

3. Little injury to emerging beet seedlings resulted from any of the applications when they were applied about 6 days before their emergence; injury to beet seedlings occurred, however, when the materials fortified with Dow General and pentachlorophenol were applied one or two days prior to emergence.

4. The sugar beet seedlings in sprayed plots developed in relatively weed-free soil, and without the competition which young weeds cause. These beet seedlings soon surpassed those which emerged in unsprayed plots in which beet seedlings entered into competition with weed seedlings.

5. Cultivation of sprayed plots was not necessary until well after thinnings.

6. The cost of blocking and thinning sprayed plots was much less than that on unsprayed plots.

7. Analysis of germination stands resulting from different seeding depths shows a greater percentage of "singles" from seeds at 2 inches than from those at shallower depths."

Some of the points brought out as a result of the work carried on by Professor Robbins and Professor Bainer are, first, it permits preparation of seed beds in the fall; second, it eliminates competition of weeds in the early stages of seedling growth; third, it reduces the number of cultivations.

The other phase of weed control, which is rather new, is that of selective weed control in alfalfa. Field observations show increased yields and prolonged productivity of old stands of alfalfa, and this method has proved successful in the control of weeds in new plantings of alfalfa.

I note from the program that the Electrovation method of weed control is to be discussed, so therefore I will not mention our experiences in California on this method at this time.

Thanks very much, and I hope to see many of you at our meeting in Sacramento.

Report of Northeastern Weed Conference Activities

By: Dale E. Wolf - New Jersey

It gives me a great deal of pleasure to be able to attend your conference again this year, and this time as a delegate from the Northeastern Weed Control Conference. The Northeastern Conference was patterned after this organization and the Western Conference and actually got its real beginning at the meeting of the North Central Conference last year. It was at that time that several of us from the Northeast began talking of the possibilities of organizing a similar conference which could serve the Northeastern states in better coordinating their weed control problems. Much credit for the actual organization of our conference must go to Dr. Robert Sweet of Cornell University and Mr. L. W. Kephart of the United States Department of Agriculture. It was the particular help of these two men which enabled us to get together for our first meeting at Cornell last February.

Before this meeting, invitations to attend were sent to 13 Northeastern states: Connecticut, Delaware, Maine, Maryland, Michigan, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia and West Virginia. Approximately 100 people from the various states attended our first meeting and the first action was to receive reports from each of the states represented on the status of research on weed control problems. After these preliminary reports it was decided that the conference should be divided into interest groups, and it was in determining what interest groups were represented that it became evident that our interests covered nearly the whole weed control field. The division at this first meeting was into seven groups. They were: field crops, turf and pasture, vegetable and potato crops, fruits, nursery and ornamentals, aquatic plants and health.

It has been determined since our first meeting that the conference would gain much more by combining these interest groups into the least number possible. After much discussion it was finally decided that we could effectively have four interest groups. They are to be (1) field crops, turf and pasture, (2) vegetable and potato crops, (3) fruits, nursery crops and ornamentals and (4) public health and welfare.

Weed control has gained much momentum in the East over the past several years and today research is being done in each of these groups and various methods are being employed in an attempt to eliminate those weeds which cause the greatest problem. In New York City alone last year 4,800 acres were

sprayed for rag weed control at a cost of about $10 an acre. Chemical weed control has meant not only a reduction in cost over hand weeding but more thorough control. Ragweed pollen count in 1947 in New York City was the lowest it has been in 12 years. Until the medical profession can find a better method of immunization against hay fever, weed control seems the best preventive.

One of the major sections of agriculture in the Northeast is vegetable production, in which the cost of hand weeding is very very high. It is estimated that the cost of weeding crops such as spinach under present conditions is about $40 per acre. Aside from this, normal cultivation must be done. The carrot growers spend about $30 an acre each year for the hand weeding and hand hoeing of their crop. The advent of using oils to control weeds in carrots has cut the cost of weeding to about $12 per acre and has also released much needed labor for other important jobs.

This season's meeting of the Northeastern Weed Control Conference will be held at the Hotel Commodore in New York City on February 12 and 13. At this time we have no way of knowing how many people will attend, but from inquiries received to date it is estimated that there will be about 500 people there. On behalf of Dr. G. H. Ahlgren, Chairman of the Northeastern Conference, I would like to extend an invitation to each of you to attend our meeting in February.

Weed control has just begun to take its place in Northeastern agriculture and there is a great need for further coordination of research. I believe that we, through the medium of weed control conferences, have taken a very important step in the proper direction. Now that we have passed our period of "birth pains" we hope to be much better organized at our meetings this year and trust that through the coordination of our research, we will be better able to serve Northeastern agriculture and the weed control field as a whole.

EVENING SESSION

Banquet - Hotel Jayhawk
J. C. Mohler, Secretary, Kansas State Board
of Agriculture, Toastmaster

Quartet from Topeka Chapter S.P.E.B.S.Q.S.A. gave several numbers that were enjoyed by all.

THE COMMERCIAL DEVELOPMENT OF AGRICULTURAL CHEMICALS

By: W. W. Allen - Dow Chemical Company

1. As you all know, agriculture is the largest single industry in the United States. As in all industries, the impact of new scientific discoveries upon the agricultural industry is such as has never occurred before in the history of man. Farming in this country is rapidly passing from an art to a

highly technical and mechanized operation. The better farmers are as scientifically trained, and as well equipped with mechanical and chemical tools as are many industrial leaders. This technological advancement has enabled the American farmer, during the war and the years following, to obtain a greater or total production with less farm labor. At the same time the farmer has received a record income. The following Table No. I should be studied to indicate the increase in gross farm income, net farm income and production expenses:

TABLE I

Gross Farm Income, Net Income & Production Expenses of Farm Operators - U.S. 1910-1945 in billions of dollars.

	1910	1920	1930	1940	1945
Gross Income	7.0	16.0	12.0	11.5	28.0
Production Exp.	3.0	9.0	7.0	6.0	11.0
Net Income	4.0	7.0	5.0	5.5	17.0

In 1930 the gross farm income was approximately 12 billion dollars, whereas in 1945 it was 28 billion dollars. Deduction of production expenses shown that the net farm income in 1930 was 5 billion dollars; whereas, in 1945 it was 17 billion dollars. This is a remarkable increase in net income for the farmer, but is nevertheless one that he well deserves since, as we all know, the farmer had many lean years through the depression period. Table No. II shows the change in farm wage rates and hourly earnings of factory workers in the United States from 1910 to 1947:

TABLE II

Farm Wage Rates and Hourly Earnings of Factory Workers - U. S. 1910 - 47.
Index Numbers (1910 to 1914 = 100%)

Year	1910	1920	1930	1940	1947
Factory Hourly Earnings	100	270	250	315	465
Farm Wage Rates	100	250	160	130	380

The index numbers are based on 1910 to 1914 as 100%. The factory hourly earnings in 1930 were 250%, whereas in 1947 they are 465%. In the same period, farm wage rates increased from 160 to 380%. There has been a large increase in labor costs, both in industrial and agricultural production. The improvement in farm income and the increase in farm wage rates have resulted in the farmer becoming a large potential user of agricultural chemicals. Many farmers have been forced to find labor saving devices in the form of machinery or chemicals to keep on operating their farms, since either the lack of labor or the high price of labor would force them to discontinue or curtail operations. The impetus to improve farm practices is very great.

The chemical industry realizes this situation; thus, more man hours, more money, and more equipment are being utilized in agricultural chemical research, development, and production than at any time previous to this. This has resulted in intensified activities by older and new companies manufacturing agricultural chemical companies that are now interested in the development, pro-

duction, and sale of agricultural chemicals. The result of this trend is illustrated in Table No. III:

TABLE III

Total Value in Millions of Dollars

	1939	1943	1944	1945	1946
Fertilizer	161.9	280.0	300.0	330.0	400.0
Insecticides & Fungicides	45.7	80.0	85.0	100.0	110.0

Concannon & Hoffheins - U. S. Dept. of Commerce
Chemical Industries - October 1947.

The value of fertilizers has increased from $161,900,000 in 1939 to $400,000,000 in 1946. The value of Insecticides and Fungicides is increased from $45,700,000 to $110,000,000 during the same period of time. Unfortunately, there were no statistics available as to the value of the various weed killers sold during this period of time. They undoubtedly would show an even greater trend of increase. The year 1947 will show a large increase over 1946, and everyone in the chemical industry is looking for expanded production and sales during 1948.

2. The chemical industry is an infant when compared with the agricultural industry, both as to age and size. However, the chemical industry has proved to be a lusty infant, and is growing at a tremendous rate. Table No. IV shows this trend:

TABLE IV

Chemical Industry. Value of Output in Millions of Dollars.

Year	1939	1943	1944	1945
Organic Chemicals	377	1,367	1,726	1,507
Inorganic Chemicals	413	869	984	998
Total	790	2,236	2,710	2,505

The total value of output from the chemical industry in 1939 was $790,000,000, whereas in 1945 it was $2,505,000,000. The growth of inorganic chemicals during this period was from $413,000,000 to $998,000,000, an increase of somewhat over 100%. The organic chemical output increased from $377,000,000 to $1,507,000,000, an increase of over 400%. It is in the organic chemical field that the chemical industry is making its greatest strides. Materials that were, only a few years ago, produced in hundreds of thousands of pounds, are now being manufactured in millions of pounds. The number of organic chemicals has increased from a few hundred to several thousand, and the number seems unlimited. The future of the chemical industry will be limited only by markets, raw materials, and the ability to construct new plants. This latter factor is a very serious one at this present time, in that raw materials and adequate labor are very short. Many plants are months or even years behind in production schedules.

The development and progress made in these two great industries, agri-

culture and chemistry, is truly amazing. It is a pleasure for me to discuss, in a small way, the relationship between the two; namely, how the chemical industry endeavors to develop products for use by agriculture. It should be remembered, although it is not part of this subject, that chemistry is also a large market for agricultural products.

In discussing the commercial development of agricultural chemicals, it will be necessary for me to draw on my experience with The Dow Chemical Company. I think the pattern that we follow is used, in general, by other chemical companies. Naturally, the detail of the pattern varies, depending upon circumstances. The origin of The Dow Chemical Company's interest in agriculture dates back to its founder, Dr. Herbert H. Dow. In addition to his abilities as a chemist, and industrialist, he showed ability in managing the farm and orchard which are a part of the original Dow estate in Midland. It was Dr. Herbert Dow's interest in orchards that led the company to its first production of Lead arsenate. From then on, our development into other products of interest to agriculture has been a steady procession. We now have 85 different products that are sold for direct use by agriculture. It also might be of interest to mention that this is the fiftieth anniversary of the founding of The Dow Chemical Company by Dr. Herbert H. Dow. His original small-scale activities in the agricultural field have led to the present large organization which The Dow Chemical Company employs to study and develop new materials for agriculture. We have approximately sixty men employed in this field of activity. The Brinewell is the symbol of the origin of The Dow Chemical Company, for it was from Michigan brine lying some 1800 feet under the ground that The Dow Chemical Company first extracted bromine and other chemicals. Its sources of raw materials now include, besides brine, sea water, petroleum, coal tar, cellulose as obtained from wood or cotton, and sulfur. From these raw materials the company now manufactures and sells over 500 different chemicals.

3. The development of chemicals for sale, whether it be for the agricultural, pharmaceutical, rubber, petroleum, or other market, takes the following general pattern:

First, the production of chemicals where a known requirement exists; for example, DDT. Development by the U. S. Government and the requirements of war resulted in a quick large-scale demand for DDT. The problem for the chemical companies was to develop laboratory, semi-plant and production facilities to manufacture DDT for the army and navy. The process of this type of chemical development is rather simple.

Second, the development of new uses for old chemicals. The chemical industry is in constant search of new ways to use old chemicals in order to employ existing facilities, or to increase them. An example of this type of activity are the efforts put forth to find new uses for lead arsenate, paradichlorobenzene, orthodichlorobenzene, sodium chlorate, etc.

Third, the development of new chemicals for new or old applications. This is the type of program that I wish to discuss in some detail tonight. The foundation stone for the commercial development of agricultural chemicals, or any other type of industrial chemical, is the chemical laboratory. The research chemists must be depended upon to supply the new chemicals which will find a place in agriculture. The Dow Chemical Company has approximately a thousand technical men with half of them being engaged in chemical research.

J.D. Turner

The number of new compounds which they produce varies considerably from year to year, and was affected greatly by the war. We estimate that in the past six or seven years of operation of our agricultural testing program approximately 12,000 compounds have been examined.

After the research chemist has developed a chemical compound, it is then supplied to our biological screening laboratories in which are located facilities to determine its bacteriological and fungicidal properties, its toxicity to man and animals, and its value in controlling pests of agricultural crops. This latter activity is carried on by a group in the agricultural research laboratories located in Midland, some two miles from the main production plant. The principal reason for this location is that chemical contamination sometimes has undesirable effects on plant and other organisms. In this laboratory a large number of chemical compounds are screened as to possible value as plant growth substances, stored product pesticides, plant fungicides, orchard, field crop and vegetable crop insecticides. These are the principal activities. However, other screening tests are run as the occasion demands. Screening operations are conducted in the greenhouse during the winter months, and in small scale field plots near the greenhouse in the summer time. Materials showing promise in the screening tests are then given to the field testing stations for further examination.

Our principal field agricultural research group is located at South Haven, Michigan, in the heart of the fruit and vegetable producing area. They are housed in a new building that was completed this fall. This operation is unique in that we do not own a farm or orchard in the South Haven area, but rather work in 30 to 40 orchards owned by commercial orchardists. We also work on a large number of truck farms. This enables us considerable latitude in going from place to place as specific problems come up.

The work of this group is to determine whether or not the materials uncovered by the screening laboratories, or brought from outside agencies have value in a particular program. The studies there involve orchard insecticides, fungicides, plant growth substances, and certain other materials. In addition, we study insecticides, fungicides, and soil fumigants on truck or vegetable crops. During the past few years much effort has been spent in developing new materials and methods for weed control in field crops, truck crops, highway, railroad, and public utility rights-of-way.

Our second field research group is located at Seal Beach, California, which is part of Orange County, the largest citrus producing county in the world. The activities of this group are similar to those at South Haven but are intensified on citrus and field vegetable crops. If after study by either or both of the field research groups, the new product still shows considerable promise, it is then ready for trial by the various government research stations. The chemical, physical and biological data are assembled for release to scientific workers in the various state and federal experiment stations. At the same time, samples of the products are made available, generally on a no-charge basis. The information and samples are sent to the various experiment station workers who show interest in the project as a result of correspondence or personal contacts. In some cases where the problem of determining whether the material is satisfactory or not involves considerable effort and expense which would not ordinarily be borne by the experiment station, "fellowships" or "grants in aid" are made. I wish to

point out that in many instances, in fact a majority of instances, the release of samples and information to the experiment stations comes prior to the completion of work by our field agricultural research groups. This is especially true in the case of materials that are not developed entirely within our own organization. An example would be, a new chemical found of value by a Federal or State experiment station worker. There would be considerable demand for the chemical by other workers which would be supplied at the same time our own research groups were working on the material.

The importance of the group working on the human or animal toxicology of new chemicals should be emphasized at this point. We have a well balanced staff of twelve employees working in this laboratory. Thousands of rats, rabbits, and guinea pigs are used each year. As soon as a new chemical shows promise which warrants the handling of fair sized quantities by any of our employees or outside personnel, it is given preliminary toxicological tests. Suggestions are given to persons handling these materials as to any possible human or animal hazard involved. Later, if the chemical seems destined for commercial production or usage, more exhaustive studies are made and the data made available together with final recommendations for handling procedures.

The next stage in the development of agricultural chemicals is experimental sales, market analysis, and technical service. The experimental data that has been obtained to date is summarized and evaluated within the company to determine if the project is sound.

All during the time the agricultural chemical is being evaluated by the biological groups, the chemists are carrying it from the laboratory or test-tube stage to semi-plant production. This allows us to supply larger quantities to our own research groups and to experiment stations that are interested. On the basis of the semi-plant production results, a decision is reached as to the feasibility of producing the material in large quantities. Important considerations in times such as these are the status of raw materials and the availability of production equipment.

Although it has not always been possible in the last few years, we do like to offer a new material for sale on an experimental basis for one year before going into an all-out sales program. In doing this, we offer reasonable quantities for sale to the better growers who are generally working in close cooperation with county agents, experiment station personnel, or one of our own technical groups. In this way we can determine the market reaction to the product and how it works in large scale operations in many parts of the country. It also serves as a means of demonstrating the value of the material to various farmer groups throughout the country. As you know, this is an important part of any sales development program.

Following a year of experimental sales or small-scale commercial sales the product is then ready for the agricultural chemical sales division. All information is then supplied for advertising purposes and for the preparation of information bulletins to be distributed to jobbers, dealers, and farmers.

In most instances, during the first few years of the commercial sale of an agricultural chemical, there is considerable technical service work to be carried on in showing how to properly use the material and also to do trouble-shooting work in case difficulties arise. This covers in a brief way our method of developing new agricultural chemicals.

We thought that you would be interested in a brief discussion of the supply situation on weedkilling materials during 1948. 2,4-dichlorophenoxyacetic acid and the various salts and esters will be available in reasonable supply during the first part of the season. However, if a large demand should result from new markets such as weed control in corn, there is very likely to be a shortage of 2,4-D materials before the end of the season. A large potential use on corn is quite apparent, and should it develop rapidly, it would affect the availability of 2,4-D during 1948. The latest report from Canada indicates that there is a possibility of five to ten million acres of grain being treated during the next season. This a larger demand than was anticipated and surely will have a serious effect on the supply situation in this country.

The amount of 2,4-D that can be made available is limited by several factors: First is the shortage of 2,4-dichlorophenol and, second, the shortage of monochloracetic acid, both of which are the intermediates used in making 2,4-D. In turn, the shortage of these two intermediates goes back further to the shortage of chlorine, phenol, and acetic acid.

The DN weedkillers will undoubtedly be in ample supply during the next season. Sodium arsenite will continue to be short and with some rise in price. Sodium chlorate will be available in reasonable supply. Pentachlorophenol and its sodium salt is in good supply and should be ample for the limited use that will be made of it in this country.

In conclusion, we wish to reemphasize that the agricultural market for chemicals is large. We feel that it will continue to grow due to the need of the farmers for lower production costs and better methods of growing crops. Also, the chemical industry is growing at a tremendous rate, and it has the means at its command to supply many of the materials required by the farmer. The record of the chemical industry has been one of continued lower costs of products. One can take the price history of many chemicals and note that as production volumes increase, product costs are greatly reduced. There has been a considerable reduction in the price of 2,4-D to date. The history of DDT is a good example of this trend. As in agriculture, this is accomplished by obtaining lower production costs through research and improved production techniques.

We can continue to look forward to the chemical industry playing an increasingly important part in agriculture as a supplier of materials and as a consumer of agricultural products.

A BROAD LOOK AT FUTURE AGRICULTURE IN THE NORTH CENTRAL AREA

By: Everett T. Winter - Mississippi Valley Association, Omaha, Nebraska

To start with I want everyone here to know that I have been framed. Sometime ago I met Noel Hanson in Cincinnati, and we spent a couple of hours batting the breeze in a hotel room. Before I got through he had explained to me to my own satisfaction, that I was to come to Topeka and talk to a group of weed eradication district supervisors. I had the impression that I was going to meet with a group of farmers, the kind that I am used to meeting, the type of people that understand me and that I understand. But when I got

here I found an entirely different group of people, Ph.D's were as common as colonels in the Air Corps. I find here at this great convention, leaders in business -- I find, secretaries and assistant secretaries of state departments of Agriculture -- and these came all the way from California to the east coast.

Needless to say, all of this completely dumbfounded me, and then to really add insult to injury, I was put at the speakers' table before this very distinguished audience -- and then the distinguished chairman proceeded to insult me. I got the significance of that dirty crack made about the noxious weeds up in northern Kansas and along the Nebraska line. I am a native of Nebraska, and I admit that we have bind weed in the southern tier of counties, but it has always been our impression that they were dragged up there by Kansans coming up to Nebraska for a drink.

I was impressed with the large number of high type business men here from such great business organizations as the Dow Chemical Foundation, and others. The pump machinery people are here -- they are all here except the farmers that I expected to meet. I did, however, meet two farmers, and I think it is unfortunate really that there are not more of them here. They are really the key men in this great program for the control of weeds.

A minister was walking along the river one day, and he saw two boys sitting on the bank fishing, one was a colored boy and the other a white boy; just as he got up to the boys the bank caved off and the colored boy fell into the water. He screamed for help -- and then the white boy, without any hesitation whatsoever, jerked off his shoes, dived in and pulled his colored friend out. About that time the minister arrived and said "son, you are a great hero, I am going to recommend you for the Carnegie medal". The kid replied, saying, "aw forgit that stuff, I am no hero at all, and I haven't done anything particularly wonderful, I had to pull him out, he had the bait in his pocket."

Seriously, I think it is a fine thing when science, industry, and agriculture, will come to a meeting of this kind to try to solve some of the problems of the country. The weed problem is one of our great problems. At a meeting of this type, especially if we had some good practical farmers here to disillusion us, we could separate the wheat from the chaff and really accomplish something.

A group of fellows came into an Illinois barber shop one day many years ago, and said that they had found a 15 pound bullfrog. They were willing to bet a little money on it, but some of the town boys said that it couldn't be done -- there just wasn't any such frog weighing 15 pounds. They argued and laid their bets, and finally picked a man by the name of Abe Lincoln, who was a very respectable attorney in town, to act as judge. Abe journeyed out into the country to see this wonderful bullfrog, and to check its weight so that he could come back and settle all bets. He came back and went for the country boys -- he said that he had seen 15 pounds of bullfrog, then added, there were 14 pounds of bull and one pound of frog.

Seriously, I think when science, agriculture, and business can sit down together and talk over problems as you have here, the country has benefitted.

For the next few minutes I would like to speak of this mid-continent area where so many of us present live. I hope this is not boring to you good people from California and from outside of our great valley, but something happened in December 1944 that would have made headlines in the newspapers all over the country had it happened at any other time than at a time when the newspapers, radios, and all means of news dissemination were filled with war news.

I have reference to the passage of an act technically known as the Flood Control Act of 1944, and a subsequent Act known as the Rivers and Harbors Act which was passed by the Congress in the following March. These Acts provide for the greatest development ever conceived for any valley in the world up to date. They provide for the authorization of the plan of Flood Control for this valley as worked out by the Corps of Army Engineers, specifically under the direction of the then Colonel Lewis A. Pick. These laws adopt the plan of reclamation for the irrigation of some five million acres of land as laid out by the Bureau of Reclamation in the arid and semi-arid parts of our valley.

It is unquestionably the most comprehensive program of development ever conceived for any valley in the world. These laws define the area of activity of the different agencies of the government that will have to do with this development. They detract in no way from the work or the policies of the Corps of Army Engineers, the Bureau of Reclamation, the Department of Agriculture, the Federal Power Commission, and the other agencies of government having to do with this great development.

We might just take a minute to check back and see how this thing came about --

Some 25 years ago, men from Missouri, Kansas, Nebraska, Iowa, South Dakota, North Dakota, and Montana, and the other states in this Missouri Basin, conceived the idea of transforming the Missouri River from a liability to an asset. The area in the Missouri Basin constitutes one-sixth of the area of the United States. The movement that ended up in what is known today as the Pick-Sloan Plan started some 25 years ago. The program was brought to a climax by General Pick when he submitted to the people in this valley and to the Congress of the United States a complete flood control program.

About the time that General Pick, then Colonel Pick, submitted his plan for flood control, a man by the name of Sloan from Montana, representing the Bureau of Reclamation, presented a program for the reclaiming of vast areas of arid land in the northern and western part of our valley. These areas were to be reclaimed from drouth through the irrigation of this vast amount of land.

As the Army Engineers worked upstream with their plan, the Bureau of Reclamation came downstream with their plan, and there was a conflict. There were some bitter words. Those of us who lived in the lower part of the valley were primarily interested in flood control. Those of us who lived in the upper part of the valley were primarily interested in the irrigation, and each group thought the other group was trying to steal all of the water in the basin. The impression got out in the southern part of the valley, that should this vast amount of land be irrigated there would not be enough water left for flood control and navigation. Likewise the people up north and west thought that those living further downstream would take all of the water to meet their needs and leave nothing for irrigation, generation of power, and the things they wanted.

As Americans generally do, we slugged it out. We had some rather bitter meetings, but eventually we got together and found that there was ample water for every need, and when the Act was passed the two programs were completely coordinated, and we have now all the legislation needed for a coordinated program for the full development of our entire valley.

There are five major objectives in this program. The first is flood control, the second is irrigation, and then comes soil conservation, navigation and power development.

The laws passed by the Congress by unanimous vote gave us for the first time in the history of the United States a complete water bill of rights. This bill of rights preserves states rights in all matters pertaining to water utilization, it provides that where water originates in states lying wholly or partially west of the 98th meridian, irrigation rights shall supersede navigation rights. In states such as Iowa, Minnesota, and Missouri, navigation and flood control rights supersede those of irrigation. In these states there is practically no irrigation.

The law authorized flood levees on both sides of the Missouri River from Sioux City to the mouth. It provides for a nine foot channel from Sioux City to the mouth. When completed, we will have an inland waterway second to none in the United States, and tying us to all the other inland waterways of the United States.

The law also provides for the development of park and recreation areas, and for many billions of kilowatt hours of electricity.

The Act preserves states rights.

To coordinate the activities of the various federal agencies having to do with this program, an inter-agency committee, consisting of five governors and the executive heads of the different federal agencies involved, has been set up. This inter-agency committee meets monthly, and to date has resolved all differences of opinion existing.

Many cruel things have been said about us here in the mid-west. We have been called the great American desert, and we have been told that in spite of the fact that seven million people live in the Missouri Basis there are fewer people in the Basin engaged in industry than are engaged in industry in the small state of New Jersey.

We believe that in the development of our valley we are going to meet the challenge made to us by the rest of the country. We believe that we can make homes here in this valley for some 636 thousand new families. We think this is a very conservative estimate, because for every new irrigation farm that we create we are going to require two more people, and that means that two more families will be engaged in business in our towns and cities.

We are going to have the use of the vast resources of this valley for the first time in history. That is not just a dream. The Act has been passed, it is the law of the land, and appropriations have been made to start the program.

During the current year, Congress appropriated 74 -1/2 million dollars to be used in the fiscal year 1948 for the "Pick" part of the Pick-Sloan Plan. The Department of Interior Agencies will have a little better than 56 million dollars to spend in the Basin during 1948 for their part of the development program.

Much of this money, of course, is construction money. This includes money for the construction of the Kanopolis Reservoir here in the state of Kansas. That, by the way, will be the first major structure to be completed in this great program.

The reservoir at Garrison, North Dakota, the one at Fort Randall, South Dakota, and the preliminary work on the big Oahe dam in South Dakota is also included. Money is included for construction work on the Harlan County Reservoir on the Republican River. This dam will be used for flood control and for the irrigation of a considerable acreage both in Kansas and Nebraska. It will provide flood protection for the industrial sections of the Kansas Citys.

Congress gave us some money but not nearly enough for the soil conservation part of this program. One bit of very important money under this heading is the one million 167 thousand dollars for the Little Sioux project. We got another amount of money for surveys on additional streams in the basin. We need a great deal more money than we are getting now for soil conservation needs. We need more money for research and for education to keep pace with this great development. There is at least a million acres of land in the Missouri Basin, now subject to flood, that will be protected from floods when this project gets under way.

This flood area is now badly infested with weeds. I think that you weed men and you specialists, both in science and in industry, have a challenge in this valley that few people realize. You are going to have about a million acres of land now subject to flood that is going to be protected from floods, and this is going to create a weed problem in that area which we have never had before.

In the five million acres of land to be irrigated under the Pick-Sloan Plan about 4,700,000 acres are new lands never before irrigated. You weed specialists will have an enormous job of controlling weeds in these new irrigation areas. I was told by an irrigation engineer the other day that the weed situation has completely changed the early concept of the irrigation engineer. The irrigation of land brings out new weed problems.

Weeds and soil erosion are the two most expensive habits that we have in this section of the country. The failure to control weeds is to neglect our soil. I learned only recently that the weed cost of the United States approximates 3 billion dollars a year.

During the fiscal year from July 1, 1946, to July 1, 1947, the United States exported 18-1/2 million long tons of food stuffs to the rest of the world. This is the largest amount ever shipped by any country in the history of the world. For the Ph.D's present I might say that this is 49.6 trillion calories of food.

The two farmers present and myself will perhaps get a better conception

of this tremendous amount of food when I say that it is enough to supplement diets of 300 million people to the extent of 450 calories a day throughout the year.

The accomplishment of this is quite a tribute to the American farmer for producing this tremendous amount of food, to the processor of this food who made it ready for consumption, and to our great transportation systems for delivering the food.

The question has been raised as to whether in our enthusiasm to increase our own profits, and to feed a starving world, we did not go too far in shipping this vast amount of food stuffs.

We who live in the Missouri Basin realize that the fundamental capital of our country is the fertile part of our soil. Many wise men have wondered if, in meeting this tremendous demand for food, we did not ship to the rest of the world a part of our capital and not just the production of our soil, and that incidentally is something to think about.

Rome ruled the world, but its world had to feed it, and Rome had to fall. England has been great but has never been able to feed itself from its own soil, or to support its vast industries from what it can dig out of the soil. Mesopotamia once had the richest soil production, but its soil was not conserved and its empire vanished, likewise Syria and Egypt. Germany did not neglect her soil, but she never had enough soil production to support her vast industrial population, and Germany had to fall.

For many years now, we know that life has been going out of our soil. It has been going out, and incidentally weeds have taken their toll. Rain and wind have been washing and blowing off our best top soil. In truth, because of this we have become a poorer nation.

Already the forces of weather have swept practically all crop growing vitality from 14% of our land. Weather and wind are steadily cutting into another billion acres of our land, and that's more than half of the land that we have left. We cannot continue to be the world's most wasteful nation and live.

Let's come back for a moment and take a look at the problem of feeding the entire world. If weeds cost the United States 3 billion dollars a year, maybe that's a good place to start rather than to cut off our exports. We know these exports have made our farmers prosperous, and the business man knows that when the farmer is prosperous he is prosperous. If we can afford a three billion dollard weed bill every year, and if we can afford to dump out of this valley some 750 million tons of top soil into the Gulf of Mexico every year, maybe that's a good place to start rather than to stop shipping the finished product.

During flood time enough soil passes the city of New Orleans, in suspension in the Mississippi River, to cover a forth acre field of land with seven inches of top soil every minute of the day.

Our wastefulness is unbelievable. The United States Department of Agriculture puts it this way: Our soil erosion losses in a year's time amounts to

twenty-one times as much as does the loss of fertility of our land from the growing of crops. I think we are getting our sights on the wrong goal when we talk about cutting down production and talk about cutting down our exports, when we should be paying more attention to the preservation of the source of all these products -- that is the good earth.

Because of the importance of this valley as the bread basket of the nation, and presently as the bread basket of the greater portion of the entire world, all of the people living in the United States have a great stake in what we do to preserve the productive power of our land. We believe that the Pick-Sloan Plan, if properly financed and properly supported, will be a great impetus to the production of needed food stuffs for years to come.

The Mississippi Valley Association is a non-profit organization of business men from each of the twenty-three states in the mid-continent area of the United States. Our organization has nothing to sell except service to its members and to the country, and no one industry contributes enough of our total budget so that that industry can use the organization for its own selfish gains.

We are organized primarily to further the interests of the mid-continent area of the United States, and we have found that one of the greatest contributions that we can make is to work with the farmers, with the Colleges of Agriculture, and with the Soil Conservation Service, and others who are devoting their attention to the stopping of this terrible soil erosion loss.

A few years ago we conceived the idea of working with these groups by putting on short courses for the soil conservation district supervisors in the several states. Just this week we completed our second short course in the state of Kansas. We have had three short courses in Iowa. We have been in Illinois, Ohio, Arkansas, and some of the other states.

A few weeks ago, when I was in western Kansas for a meeting with a group of soil conservation leaders to plan our recent short course for Kansas, I received some very basic philosophy from a Kansas farmer.

It's fun to kid you business men about being interested in this meeting solely for the purpose of selling spray materials and spray equipment. It's fun to kid our scientists as we have done here tonight, but I know and I sincerely believe that the interest of you scientists and you business men in this meeting goes much deeper than it could go through any selfish motives. I believe that your basic philosophy is the same as that of my Kansas farmer friend, to whom I referred a minute ago. This is what he said --

"God gave us the land to tend not to spend. He gave it to us to cultivate, to preserve, to use, to live upon. He gave it to us to furnish us with food and clothing and what else we need to live happily and comfortably. Good land is the basis of our civilization. It is God's gift to man, and it's our sacred duty to protect and to preserve it and to pass it on to future generations so that they too may fully enjoy the benefits and opportunities which we have inherited."

It is carrying out a great American tradition when you scientists, you business men, and you agricultural leaders sit down together to attempt to solve some of the great problems of our country.

You are determining not simply how to destroy certain weeds, but you are dealing with the subject that directly affects our very civilization.

To you men who come from the Missouri Basin, I want to say to you that I believe that we are going to make a Garden of Eden out of this basin, and that it is your job to keep the weeds out of it.

FRIDAY MORNING SESSION

WEED CONTROL EQUIPMENT
E. P. Sylwester, Chairman

LOW VOLUME APPLICATIONS
L. M. Stahler, Leader

Developments and Results of Airplane Application of Herbicide Sprays
By: H. A. Waters - Sherwin-Williams Company

The application of herbicides by airplane sprays is a comparatively new development. The application of dusts for plane for the control of insects and plant diseases has been standard practice for many years, but the adaptation of planes to apply liquids to agricultural crops is still in its infancy. As a result our knowledge of plane spray equipment and how to use it is in a developmental and rapidly changing state.

Airplane spraying should be recognized as being distinctly different from airplane dusting. Dusting is far more hazardous from the drift standpoint. With proper equipment and management airplane spraying can be comparatively safe operation.

Dinitro sprays for selective weed control in such crops as grain and flax have been applied by plane for several years. A water solution, usually about 14 gallons per acre, was used. This volume of water was required for proper performance of this type of herbicide. As a result an average plane load would cover only five acres, making the cost of application relatively high.

With the advent of 2,4-D plane spray tests soon demonstrated that 2,4-D could be used successfully with far less liquid per acre. The idea of low-gallonage application by plane was studied intensively leading to the development of specialized plane spray equipment, and eventually to the development of successful low gallonage ground spray machines in 1947.

The first 2,4-D plane sprays were put on by the planes equipped to apply Dinitro compounds, using 2,4-D salts in water at a rate of ten to fourteen gallons per acre. Considerable grain was sprayed in the manner in California in early 1946.

The next trials were made in Florida in the spring of 1946, using TEA salt in as low as two gallons of water per acre for water hyacinth control. As

this test progressed, it was found that oil soluble 2,4-D in deisel fuel oil, using as low as five quarts of oil spray per acre, gave still better results.

During late October 1946, the writer and his associates in cooperation with Noel Hansen of the Nebraska Experiment Station, conducted low-gallonage plane applications on winter wheat at Lincoln, Nebraska. These trials demonstrated that as low as five quarts of oil spray per acre was satisfactory.

These trials laid the groundwork for the first commercial low-gallonage plane applications on grain in California in January, February and March of 1947. Some 25,000 acres of barley and oats were successfully treated for mustard control using 2,4-D both in water and oil, using 2 to 5 gallons of water or 2 gallons of oil per acre.

During 1946 and 1947 Dr. Hess of T.V.A. studied airplane spray applications. He used as low as one pint total spray per acre. It was found that the fine atomization required for this low rate resulted in excessive drift, indicating that there is a definite practical limit to how low a volume can be used.

During the late spring of 1947 over 100,000 acres of grain in Minnesota, North Dakota, South Dakota and Montana were treated by plane. Most of this work was done with butyl ester 2,4-D in Deisel fuel oil. At the start two gallons of oil spray per acre was used. As the season progressed this was reduced to one gallon total spray per acre with equally good results. The season ended in this area before sufficient information was obtained on the rate of two quarts total oil spray per acre. However, in Canada large scale commercial plane applications using ester in two U. S. quarts of total oil spray per acre gave excellent weed control.

This was followed by successful commercial low-gallonage plane application on several thousand acres of corn in midwestern states.

During the 1947 season several thousands acres of rice were treated by low-gallonage plane applications. The results here were not as uniformly good as had been secured on grain. Apparently the rice problem is more involved because of such factors as more resistant weeds, complications resulting from treating in relation to weed maturity and rice flooding practices, and the fact that some of the planes used were improperly equipped and improperly flown. Much more work is needed on the subject of plane spray applications on rice.

Several types of planes are adaptable for spraying. The type is governed by the scale of operations and the size and location of the fields. For small scale operations or for small fields with high obstructions light monoplanes, such as the Aeronica are suitable. They carry up to a thirty-five gallon load, fly sixty miles an hour and cover a swath up to 50 feet wide.

The most common type in use is the Stearman, or other makes of comparable size, which carries eighty gallons, flies eighty miles per hour and can cover a swath up to 100 feet wide.

In Canada, Mr. Holmes, of Winnipeg equipped several Lysander planes, a high-wing monoplane built for war use. These carry 220 gallons, fly 160 miles per hour and cover a swath 160 feet or more in width. Planes this size are adapted to use where there are large grain acreages.

It is now generally agreed that a long boom under the wings is preferable to a short boom under the center of the plane. The long boom gives better distribution especially if the pilot should fly too low. It makes a better impression on the field owner as the distribution can be observed better visually.

The nozzle selected should be one that reduces the spray liquid to a thin sheet before it strikes the air, as opposed to one that shoots out a solid stream from a simple hole in the boom. The thin sheet can be a hollow cone, as is secured with the "Whirl-Jet" type of nozzle of Spraying System Company of Chicago, Illinois, or the flat sheet obtained from a "Vee-Jet" nozzle made by the same company. Other types are also available. These come with different flow rates, so by varying the pressure and nozzle size the pilot can adjust the delivery rate to the desired range.

The droplet size can be regulated by the combination of pressure and nozzle aperture chosen, and by the angle that the nozzle faces into the wind. The usual position is pointing straight back for 2,4-D sprays. Finer sprays can be secured by tilting the nozzle up or down.

In general a nozzle pressure of 20 to 30 pounds is satisfactory. A nozzle aperture of either of these nozzles mentioned above which gives the desired flow rate at 20 to 30 pounds will give about the right droplet size for 2,4-D sprays.

The outer nozzle on each side should be at least a few inches inside the point where the curvature of the end of the wing begins. The spray from nozzles out beyond this point is carried high into the air by air currents and increases the drift.

Both gear and centrifugal pumps can be used, the latter type being used if application of suspended solid matter is to be made. A potential pressure of at least forty pounds is desirable, especially if check valves are used on the nozzles. The pump is usually operated by a fan blade.

There should be a pressure gauge in the cockpit that gives the boom pressure, and a hand valve for regulating this pressure, preferably one that can be adjusted while in flight.

A height of fifteen feet has been found best for most planes. It should not be lower, but can be a few feet higher, if the wind is not excessive.

Each nozzle should have some mechanism to stop the flow of spray the instant the spray supply is cut off to eliminate spray being delivered on the adjoining field after the spray is cut off. Ball and spring check valves work fairly well, but may be prevented from closing, if dirt gets on the ball or ball seat. Some use mechanically operated closing devices. Electrically operated valves and diaphram type valves are being investigated. This phase of the equipment requires more study. If check valves, requiring a given pressure for opening, are used, add this opening pressure to the nozzle pressure needed for desired flow rate to get the needed boom pressure.

A convenient formula for calculating the flow rate of a nozzle needed for a given gallonage per acre is as follows:

gallons per minute for entire plane	=	miles per hour	X	gallons per acre	x	feet of swath width	x .002

To determine the flow rate needed per nozzle divide the above answer by the number of nozzles on the boom.

Here are other variations of the above formula

$$\text{Miles per hour} = \frac{\text{gallons per minute for entire plane} \times 500}{\text{gallons per acre} \times \text{feet of swath width}}$$

$$\text{Gallons per acre} = \frac{\text{gallons per minute for entire plane} \times 500}{\text{miles per hour} \times \text{feet of swath width}}$$

$$\text{Feet of swath width} = \frac{\text{gallons per minute for entire plane} \times 500}{\text{miles per hour} \times \text{gallons per acre}}$$

Nozzles need not be spaced closer than two feet and might possibly be further apart.

Applications should not be made if the wind is excessive. Twelve to fifteen miles per hour is a limit commonly used. It is suggested that anemometer be used to measure the wind, rather than guess.

Care must be taken to prevent drift to adjoining fields of sensitive crops. By timing the spraying in relation to the wind the drift can be controlled even if it means spraying opposite sides of the field at different times, when the wind has changed.

Be sure that the pump and piping system does not leak and get spray on fields where it is not wanted.

Spray planes must conform to C. A. A. regulations so far as the flying structure and load is concerned and must be so approved before use.

Licensing and regulation of spray plane operators, as is now done in Minnesota, is a good practice that will help eliminate poor pilots and improper equipment.

From the standpoint of economy, that is the number of the acres that can be treated per plane load, the oil soluble or ester type 2,4-D has proven the most practical, since a considerably lower volume of oil per acre can be used than is practical for water. Oil, because of its lower evaporation rate, evaporates less while falling, and penetrates weed foliage faster. For weeds in such crops as grain and corn, one gallon per acre has proven sufficient with considerable evidence that in many situations two quarts per acre will be enough. Salts of 2,4-D will not dissolve in oil. For water sprays two to four gallons per acre is required. This difference means that with oil a plane load can cover two to eight times the acreage possible with water sprays, making esters preferable for the lowest volume applications.

Diesel fuel oil No. 2 is the preferred grade of oil, although Diesol Fuel

Oil No. 3 can also be successfully used. Diesel Fuel No. 1 or kerosene tends to break up into too fine a mist. Diesel oil has the advantage over other oils of being cheap, and readily available in most areas.

Experience on over 150,000 acres of commercial application on grain, corn and rice in 1947 has proven that the spray plane can do a good job in many agricultural areas, and is a valuable tool in 2,4-D application. In large fields it is quick and economical, and is especially useful when the ground is too wet for ground spray rigs. Several hundred spray planes will be in operation in 1948.

An interesting development is now in progress by Longcoy and Shreve of the Aereal Insecticiding Company of Orlando, Florida. They are starting a training school for plane spray pilots. They also make and install approved spray equipment for light and medium size planes. Ventures of this type will do much to promote the advancement of airplane spraying.

Since Mr. Longcoy is in the audience, I will call on him to describe their school, equipment, and planes.

Application of Highly Concentrated Solutions Of 2,4-D For Weed Control

By: W. P. McDonald - F. H. Peavey and Company

Thank you Dr. Stahler, gentlemen. I can certainly agree with what both Mr. Sylwester and Dr. Stahler have said in reference to the progress that has been made since one year ago. I am sure a lot of you men will recall the remarks that were made last year with reference to volume rates. Generally speaking we talked about 80 to 160 gallons of water to the acre, with ground equipment, but you will recall, we had a speaker here from TVA last year who mentioned success with airplanes, using a straight concentrate without any diluent whatsoever. That was quite a challenge to those of us who are working with ground driven equipment and while we haven't got all of the diluent out yet, we have gotten a lot of it out. A review of the information available, certainly establishes the fact that highly concentrated 2,4-D solutions are fully as effective as low concentrations. Generally speaking, the equipment being offered for application has kept pace with research.

Information obtained by F. H. Peavey and Company, in cooperation with the University of California in February and March lf 1947 was the basis for a recommendation in the spring wheat area during the past season. In these California tests, it was established that ground equipment can make successful applications of 2,4-D at less than two gallons of solution per acre, and that the distribution is sufficiently good to produce weed control comparable to or exceeding that obtained with any volume of water up to or beyond a hundred gallons.

Several hundred Northwest farmers adapted their ground equipment to apply approximately ten gallons of solution per acre during the summer of 1947. At the close of the season, approximately 700 questionnaires were mailed out to sprayer operators to determine the results obtained. Surprisingly enough, this was a rather long and detailed questionnaire, but out of 700 inquiries, we re-

ceived replies from 468 which indicates a very keen interest on the part of our farmers in solving some of these problems. Of those replying out of the 468, approximately 50% of them used ten gallons or less, per acre. The following table is a tabulation of the results reported:

Comparative Results of Low and High Volume Spraying

10-GALLON SPRAYING on Wheat, Barley, Oats		MORE THAN 10 GALLONS on Wheat, Barley, Oats	
Very Good to Good Results	98.3%	Very Good to Good Results	96.0%
Fair results	1.7%	Fair results	1.8%
Poor results	0.0%	Poor results	2.2%
on Mustard		on Mustard	
Very Good to Good control	98.2%	Very Good to Good control	94.3%
Fair control	1.8%	Fair control	4.6%
Poor control	0.0%	Poor control	1.1%
on Canada Thistle		on Canada Thistle	
Very Good to Good control	58.0%	Very Good to Good control	46.2%
Fair control	40.0%	Fair control	45.0%
Poor control	2.0%	Poor control	8.8%
on Sow Thistle		on Sow Thistle	
Very Good to Good control	47.2%	Very Good to Good control	33.3%
Fair control	40.3%	Fair control	45.2%
Poor control	12.5%	Poor control	21.5%
on Other Weeds		on Other Weeds	
Very Good to Good control	86.7%	Very Good to Good control	67.3%
Fair control	13.3%	Fair control	21.8%
Poor control	0.0%	Poor control	10.9%

I am sure that I wouldn't attempt to explain why the low volume applications appear to have given better satisfaction. I wonder perhaps, if some of our better farmers didn't avail themselves of the information, and perhaps they were just a little more careful groups of sprayer operators. We just don't seem to have any other justification for it, but it certainly did establish that those who were willing to take a chance last spring on a recommendation of ten gallons per acre had no reason to regret that action. The reason, of course, that ten gallons was used in our particular case was that last spring when these tests were run in California, we used a Fargo Sprayer of the type that was available up there in our part of the country, and we had to use some method of adapting those sprayers, so we simply changed the nozzles, and changed the spacing and used the same sprayers. We knew that we could have gone down as low as two gallons or even less, but we didn't like the extremely low volume nozzles available at that time. In fact, they weren't available in sufficient quantity, and we weren't just too well satisfied with the performance of them.

It is clear from the above, that farmers generally are of the opinion that low volume applications are as good or better than high volume. As a further check on the results that could be obtained in the spring wheat area, 400 plots were laid out co-operatively by the Bureau of Plant Industry, F. H. Peavey and Company, and experiment stations in North Dakota, South Dakota and Minnesota this past season. Approximately 200 plots were on oats, 100 on barley and 100 on durum wheat. Principal annual weeds involved were mustard, Frenchweed, wild buckwheat, sunflower and cockleburs. The principal perennials were field bindweed, Canada thistle and sow thistle.

All plots were randomized and replicated three times. Twelve ounces of a 2,4-D ester, an amine and a sodium salt were applied at rates of eighty, forty, twenty, ten, five and 2½ gallons of solution per acre. An especially designed Fargo Sprayer was used to make the application. An examination of the results obtained in these tests revealed that there was no significant difference in weed control obtained at the various rates. Understand that the quantity of 2,4-D of each of the three formulations were constant. The only variable was water. Neither was there a significant difference in the effect of the applications on the economic crop. Bushel test weights were very uniform as was germination. This series of tests seem to confirm that the amount of carrier is relatively unimportant as long as satisfactory distribution of the active principal is obtained. Low volume application makes weed control much more attractive to the farmer.

Nozzles currently available make the application of five gallons of solution per acre an entirely practical rate. The saving here is obvious when compared to 100 gallons per acre which was generally recommended one year ago. A low rate also effects a material saving in the original cost of equipment. In the spring wheat area where there are relatively few susceptible crops, there appears to be little or no hazard from drift even at the lowest volume per acre, which naturally require reduced droplet size. In connection with the survey of farmers using the ten gallon rate during the past season, which was mentioned previously, 44% said they had noted some drift but that it was not serious. The remaining 56% reported that they had observed no drift whatsoever.

Following are the comments of a number of workers who have been interested in the matter of low volume applications:

Dr. L. M. Stahler, Bureau of Plant Industry - "We recommend the lowest volume that can be applied with available equipment. Five gallons per acre as a standard rate".

Agricultural Supply Company, Grand Forks, North Dakota - "As a whole, low volumes of water (2½ to 20 gallons per acre) have been very successful in the application of 2,4-D ***** In our own tests with ground equipment we had equally good results on moderately sized grain and weeds with 2½ gallons of spray per acre as we did with 5, 10, 20 and 50 gallons of water when the same amount of 2,4-D was applied per acre".

L. A. Jensen, Extension Agronomist, North Dakota Agricultural College - "With respect to your letter concerning the general satisfaction of results with the low water volume application of 2,4-D, I can only say that they have been very satisfactory. This has been true in spite of what I would call generally poor nozzles, that is nozzles that did not give a uniform application * * * * *

There is no question in my mind but that farmers generally are going to use the low water volume method of application even more extensively than it was used this year".

Lyle A. Derscheid, Assistant Agronomist, South Dakota State College - "From a casual observation of the data obtained this season, it appears that the 2½ gallon rates were as effective as the 80 gallon rates with respect to annual weed control and also field bindweed control * * * * * We are going to recommend the use of from 5 to 10 gallons per acre this coming year so you see that we feel that the low volumes are as satisfactory as higher volumes".

Geo. M. Briggs, Extension Specialist in Field Crops, University of Wisconsin - "I have come across a few farmers and demonstrators who have been using lower volumes with high concentrations and they seem to feel that it offers great opportunities".

Keith C. Barrons, Agronomist, Dow Chemical Company - "We have made many tests of low versus high volume applying the same amount of 2,4-D per given area. In general, we have found low volume to be very satisfactory where the vegetation is all about on the same level such as one finds in grain * * * * * We can see no reason why 5 gallons per acre is not satisfactory for grain if one has a suitable rig".

H. E. Wood, Manitoba Department of Agriculture - "Of the half million acres treated with selective chemical in 1947 in the three Prairie Provinces most of the chemical was applied as sprays and mostly by low volume (4 to 20 imperial gallons) boom sprayers".

Dr. T. K. Pavlychenko, University of Saskatchewan - "The 10-gallon volume nozzles give fully satisfactory results with 2,4-D * * * * * There were numerous machines in use in Saskatchewan applying only 4 gallons of water per acre and the results were satisfactory unless the machine was not working properly. The general trend seems to be in the direction of a low volume machine".

H. C. Fulton, Standard Agricultural Chemicals, Inc. - "In our trials in North Dakota this season where a constant amount of 2,4-D was applied with 5 gallons of water in comparison with high rates per acre, weed control was fully as good on the low volume plots and, in this test at least, crop yields were actually better than where high volumes were used".

F. C. Vodrey, National Grain Company, Ltd., Winnipeg - "Regarding the matter about which you wrote me, all the spray rigs in this country are equipped with low volume nozzles. Some 3 gallons, others 4, and the large majority with 5 gallons of water per acre. Large amounts are not even mentioned. In other words, there is no comparison. It is taken for granted that low volume spraying is the accepted principal".

E. P. Sylwester, Iowa State College - "Low gallonage, high concentrate sprays are beginning to come into general use in Iowa * * * * * For ground equipment, usually 5 to 10 gallons have been used per acre * * * * * Sprayings made, especially in corn, using low gallonages have been very satisfactory and no harm has resulted to corn".

Dr. E. D. Witman, The Sherwin-Williams Company - "In large scale spraying,

the concentrated sprays are replacing the conventional dilute sprays. Weed control, crop injury and drift are considered to be about equal for either method, but the concentrated sprays can be applied more cheaply and with greater ease. The concentrated sprays appear to penetrate dense foliage better than the dilute sprays".

I think the comments from the various gentlemen quoted here make a pretty firm case for low volume applications. Thank you, gentlemen.

The Use of 2,4-D Dusts and Ground Dusting

By: Gordon A. Brandes
Rohm & Hess Company, Philadelphia, Pa.

There are many methods and types of equipment that have been used successfully in the application of weed control chemicals, but it is doubtful whether any one method will best meet all requirements under all conditions. The nature of the weed problem, accessibility and size of the area to be treated, complexity of the cropping pattern of the locality, cost, labor requirements and to a certain extent the personal preference of the user will all determine the method and equipment to be employed.

Dusting is most adapted to the "wide open spaces" which are engaged principally in small grain production. 2,4-D dusting in areas where cotton, sugar beets, most vegetables and fruits are grown extensively, is definitely limited, if not altogether restricted.

Functional requirements of any pest control equipment including dusters, are to uniformly distribute the correct amount of material in the proper place. Many commercial dusters now on the market fail to meet these standards. Because of their design and construction, certain types have erratic feed rates and uneven distribution to all parts of the boom. Some dusters cause a fractionation or separation of the dust components and may result in low initial deposit and poor adhesion in spite of the mixing methods and materials used in the dust.

Under field conditions where a wider latitude of performance is tolerable, failure to meet functional requirements exactly may not be as important to achieve a satisfactory degree of practical control. This is especially true when insecticides and fungicides are applied in relatively large dosages. But, in the case of 2,4-D which is used at extremely low rates, the performance of the equipment must be more accurate. It is very important in detailed research studies, that the equipment used be especially exacting. Several research workers have reported that erratic mechanical performance frequently causes greater differences in pest control than differences in effectiveness of various dust materials or dosages used.

We are indebted to Mr. Frank Irons and his associates at the U.S.D.A. Pest Control Equipment Laboratory, Toledo, Ohio, and others, for their studies of a fundamental nature of dusting machines and materials.

Most commercial dusters have gravity feed hoppers in which the rate of

flow varies with the level of the dust supply. Freshly mixed dust flows better than dust that has stood around and become more settled and packed. Extremely fine dust will not flow as readily as slightly coarser mixtures. Different carriers and the ingredients themselves will cause variations in the rate of flow. Good agitation in the hopper that brings the dust to its near maximum fluffiness will overcome most of these objections. Keeping the hopper as nearly full as possible, never letting it get below the 1/4 mark, will help maintain a more even rate of delivery in any type of gravity hopper. U.S.D.A. engineers have developed a vertical impeller that thoroughly fluffs the dust and elevates it through a central tube where it is discharged into a positively adjusted dust feed to the fan. The deviation in feed rate with any given dust is less than 2%. Hoppers with a rod arrangement sliding over the dust slot or simple spider agitators should be avoided.

Uneven distribution of the dust or certain fractions of it may be caused by the design of the blower and distributing system. There are two general types of fans in common use today; the single and multiple outlet. As the name implies the single outlet fan has one outlet from which the dust goes to a distributing box or device where it is divided further and distributed to the boom.

The most desirable arrangement of this type is to have the dust make as few bends as possible. The effect of turbulence and centrifugal force in the air stream cause more dust to flow to one side than the other, or the particles of dust themselves may separate and heavier amounts of the active ingredient go to certain parts of the boom. Dusters with close 90 degree turns leading to the distributing box or short and sharply bended hoses should be avoided.

The multiple outlet fan has openings evenly spaced around the outside edge of the fan case. Individual hoses lead from the fan to the boom. This type of distribution system gives very good distribution to all parts of the boom. Fans should have capacity enough to deliver the air at reasonably high volume and velocity, according to the size of the boom employed.

There are several types of booms available; consisting of either tubular styles, individual hoses and nozzles, or combinations of both. All can be used for weed dusting. The tubular design, which is essentially a light-weight pipe with holes on the underside, permits longer booms because of their simplicity and lighter weight. They can be carried closer to the ground which reduces drift and provides more uniform distribution of the dust to each square inch of surface treated.

We used only Niagra 40' tubular boom machines although shorter lengths are available. The boom was in two 20' sections being $3\frac{1}{2}$ inches in diameter at the center and going down to 2 inches at the ends. The holes on the under side were 3 inches apart and were $\frac{1}{4}$ inch in diameter at the center, gradually increasing to 3/8 inch at the ends. This decrease in the diameter of the tube and increase in the size of the holes toward the outer end, compensates for a reduced air pressure and equalizes dust distribution at all points of the boom. This is carried 6 to 12" above the weeds or crop.

On individual nozzle types, designed primarily for row crop application, the hoses can be rearranged in a straight line with equal spacing for weed dust use. Because individual nozzles have a tendency to give streaked application, the nozzles should not be more than 18" apart and probably only 12 or 15". If

wider spacing than 18" is used it requires carrying the boom so high from the target that the force of the air blast is dissipated before the dust reaches the weeds and the possibility of drift is increased. The nozzles are carried 15 to 20" above the weeds.

Flat spreading nozzles are preferred to open hose outlets for more even distribution. Because the average six row, 2 nozzle per row duster will only provide a maximum swath of 18' for drilled crop dusting, we developed a tubular boom attachment for this style of machine. This consisted of 3 sections of 2½" light-weight tubing with 3/8" holes spaced 3" apart on the underside. Each section was fitted with 4 leads for the individual dust hoses. This machine then had an operating width of 24 feet and gave uniform distribution with the boom carried only 6 inches above the weeds.

Large sized row crop dusters such as the Niagra cyclone 8 row, 3 nozzles per row, or 24 nozzles in all gave good results. The individual nozzles were spaced about 15 inches apart and this covered a 30' swath. Canvas hoods or tarpaulins should be used on all dusters. The hood holds down drift, prevents some waste, and provides more uniform distribution of the dust through the boiling action, and permits operation under conditions of higher wind.

Dusters can be mounted on a trailer or truck or directly on the tractor. In the Red River Valley of the north where several thousand dusters are used on potatoes, it is estimated that all but 3% are of the trailer type. The trailer duster is easily attached or unhooked with a single draw bar pin and lends itself to pulling with tractors, jeeps or pickups, without tying up the source of power when not dusting.

Tractor mounted machines, in spite of improvements in the ease of dismanteling still take time to take off and put on and usually result in full time tieup of the equipment for the entire season. The booms on tractor mounted tubular boom types have to actually be taken apart for going through gates and road travel, whereas the boom readily folds ahead on the trailer type. The tractor mounted duster eliminates an additional set of wheel tracks in the grain, but this may not be of too much importance in the case of light weight dusting machines.

Dusters may be powered by auxiliary gasoline engines, power takeoff or ground drive. Auxiliary engines are most widely used in the Red River Valley, although a few power take off types have been coming in recently. There is little difference in the initial cost between power-take-off or engine driven trailer types. Power take-off on tractor mounted styles is easier to install and would probably cost less.

Many farmers make good use of their duster engines for miscellaneous jobs during the off season. Ground drive machines seem to be on the way out. Although they are low in cost they do not develop as much air blast as now considered desirable for best results.

Comparisons were made between methyl and iso-propyl ester, monohydrate sodium salt, acid-sodium bicarbonate admixture and free acid. At 10 pounds little difference could be noted, but at 5 lbs. or 4 oz. acid equivalent, the

superiority of esters over salt or acid mixtures was readily apparent, both on annuals and particularly on perennials. Ester dusts were more effective than salts when rain immediately followed application. Dew was not considered necessary, particularly for ester dusts.

Approximately 40,000 acres in the Dakotas and Minnesota and 70,000 acres in Manitoba and Saskatchewan were treated with 2,4-D dust in ground machines during the 1947 season. Nearly all of the work was for selective weed control in growing grain. Results with a given amount of 2,4-D have been very comparable to wet spraying. True, there were cases of crop damage with dusting just as there were with spraying. But where moderate dosages were applied not, exceeding 1/2 to 3/4 lbs. of acid equivalent per acre, it was felt the damage was due to either a too early or too late stage of growth at the time of treating.

On the basis of our 1946 experience, 10 to 12 pounds of 5% ester dust per acre was recommended for general usage in 1947. It was apparent early in the 1947 season that less material would do a satisfactory job.

Much of the dusting was done at 5 to 7 pounds and gave good control of mustards, marshelder, kinghead, pigweed, lambsquarters, Frenchweed and hedge bindweed and effectively stunted wild buckwheat, Canada thistle, sow thistle and field bindweed. Higher rates were used and are recommended where less susceptible perennials are a major problem. Twelve to fifteen lbs. of 5% methyl ester dust gave good control of field bindweed, in grain fields when applied in early June in south central South Dakota.

There were no cases of serious damage from dust drift, although 2,4-D response was noted in the case of two alfalfa fields and one field on Canada peas. These seemed to completely recover in 2 to 3 weeks time and no readily apparent effect on yield was noted. Some 2,4-D response from drift was also noted in groves and shelter belts, especially on boxelder and caragana, but these two seemed to recover after a short while with no permanent damage resulting during the 1947 season.

Operators of dusters furnished by the Agricultural Supply Company were told to stay 1/4 mile away from sensitive crops. This suggestion was not rigidly adhered to and it appears now that the 1/4 mile limit was being overcautious. This statement can not be proven by factual data but is a result of many field observations, it would seem reasonably safe to say dusting could be done safely within 10 to 20 rods on the leeward side of a sensitive crop such as potatoes, peas, and forage legumes. This would not necessarily apply to cotton or other sensitive crops in other areas. Under ordinary conditions, a dust cloud will be so dispersed and diluted in 10 to 20 rods that the actual amount of 2,4-D that settles will be too little to cause damage.

Several tests were made with an experimental machine termed a "Liqui-duster". This was a fixed boom duster with a Liquid spray attachment, that delivered approximately 5 gallons of water per acre into the dust stream as it was discharged through the nozzles or tubular boom. Although this machine accomplished some reduction in dust drift, it is not considered feasible in view of the success of 2,4-D treatments in the same amount or less of spray used alone.

Summary

The limitations where dust applications of 2,4-D can be used will be determined largely by the drift hazards involved. The time of application will be limited by wind conditions and much dusting will have to be done in the early morning or evening and at night. Winds up to 10 or 12 miles an hour are satisfactory. Traveling cross-wind is helpful. A rule of thumb that may be applied would be to quit dusting when the canvas hood completely billows from the ground.

Dusting materials will probably cost slightly more per acre because the 2,4-D dust is a finished product which involves additional material, preparation and labor costs. Prices are not set up as yet for 1948 but the cost of material for general selective weed control will probably be about $0.90 or less per acre. An additional cost not exceeding $0.15 per acre and probably less will cover labor, power and depreciation on the equipment. The initial investment in a dusting machine is high as compared to new type low volume sprayers.

Dusts eliminate water hauling altogether which represents the biggest saving in labor. No investment is necessary for water transportation equipment. The quantity and quality of water for spreading is definitely limited in many areas which makes dusting particularly feasible.

The dusts are ready mixed and only require emptying into the hopper. Most dusters require little special care and will last for a period of years with a minimum of upkeep. Dusts represent considerable less weight of material compared to Liquid sprays. Five to ten pounds of dust can be used where 21 to 85 pounds of water would be required to spray at 2½ to 10 gallons per acre, respectively. This reduction in weight is a definite saving which will often permit the use of dust equipment in wet fields where moderately sized equipment would bog down. Patch treatment with hand dusters would represent a considerable saving in labor as compared to hand sprayer treatment.

Although some material will be lost by drift, dust applications will achieve a high degree of efficiency through thorough coverage and good penetration, particularly in dense vegetation, equal to if not exceeding low volume sprays where the upper stories of foliage may intercept a high percentage of the liquid.

Lack of uniformity of distribution is one of the greatest weaknesses of aerial application of dust materials. Too much material is deposited in the center of the line of flight and too little at the edges. We have done only a limited amount of work with airplane application of 2,4-D. We have had more experience with insecticide and fungicide application. A stearman or similar type bi-wing plane should confine its swath to 30 feet. A cub type plane to 20 feet. By flying a closer swath with a smaller opening in the venturi a considerable portion of the area is actually hit with the propeller blast.

The helicopter was widely used in Canada with generally effective results. Although this machine actually has a power blower incorporated into it, our observation was that they definitely streaked the field.

If satisfactory weed control is being achieved in the spaces between the line of flight then some of the heavier deposit immediately under the plane or

helicopter is being wasted and there is a possibility of over dosage of that part of the swath.

Aircraft can be used only for daylight operations and the drift is even harder to control than with ground machines. This further limits the use of dusting in areas where sensitive plants grow.

Aerial equipment is expensive and requires trained operators. This is even more true of the helicopter. Cost of application will run considerably higher than ground equipment. Plane operators in the Red River Valley charged 3½ to 5 cents a pound for dusting with a minimum of 50 cents an acre regardless of poundage. Helicopters charged $1.00 to $1.50 per acre in Canada in 1947.

Effect of 2,4-D Airplane Spray On Cotton

By: T. F. Hall, Botanist
Tennessee Valley Authority, Wilson Dam, Alabama

Previously, airplane applications of 2,4-D sprays, including the butyl ester, methyl ester, and triethanolamine salt, have been made successfully to certain littoral plants in reservoirs without evidence of excessive "drift". In all of these instances the maximum drift observed was well within a few hundred feet of the treatment area as reflected by the subsequent development of formative effects in highly sensitive plants such as cocklebur and trumpet vine. In the early summer of 1947, formagenic effects were found in seedling cotton up to one and one-half miles distant from the block treatment area where the full butyl ester concentrate was applied at a rate of approximately 3 pints to the acre (about 3 lbs. 2,4-D per acre) with a Vultee BT-13A spray plane. Cotton which was not above the soil surface at the time of application showed no visible response to 2,4-D. On the other hand, seedlings above the soil surface at the time of exposure to 2,4-D responded by: (1) a supression of growth of the apical bud, (2) an increase in emergence of axillary shoots, (3) abnormally dissected leaves, and (4) pebbling of the leaf blades. The degree of the response appeared to decrease directly with the increase in distance from the treatment area. The formative effects were produced only in new growth emerging a short period following the exposure of the plants to 2,4-D. The plants subsequently produced normal foliage, flowered freely, and apparently produced a normal crop.

Because of the experience of formative effects appearing in seedling cotton up to one and one-half miles from the block treatment area, the airplane application of 2,4-D concentrates in routine areas for the control of plants important in malaria control where cotton is prevalent has been temporarily abandoned in the Tennessee Valley. Temporary abandonment of such airplane treatment has been made during the active cotton growing season pending the accumulation of additional information on the operation. It is not known whether or not the formative effects observed were due to drift of particles, fumes, possible dribble from check valves, or material carried in the wake of the ship maneuvering in the area. Regardless of the factor or combination of factors involved, this experience shows that extreme caution should be exercised if one contemplates applying 2,4-D sprays by airplane in a region where cotton is prevalent. Although the light dosage of 2,4-D on

cotton seedlings did not prevent fruiting, it should be pointed out that drift from a ground spray unit on cotton while in flower bud and in flower decreased the yield markedly with unmistakable 2,4-D injury to the crop.

Special Applicators

By: Geo. Knowles
Central Experimental Farm, Ottawa, Canada

Previous to 1946 the Field Husbandry Division was more interested in dusting than in spraying for weed control. Up to that date spraying for weed control involved the use of 50 or more gallons of water per acre. The use of so much water was considered impractical especially in the dry areas of the three Prairie Provinces. For this reason a search was commenced for a chemical dust that would kill weeds without water.

Several herbicidal dusts were tried but the most promising was a mixture of calcium cyanamide and calcium chloride. This hygroscopic mixture started the herbicidal action of cyanamid under dry conditions. This mixture was difficult to apply because it adhered to the tubes of the conventional duster. The difficulty was finally overcome by making a duster without tubes. This appliance was a crude miniature of the modern turbine duster, but while the turbine blows dust too far, the one made by the Field Husbandry Division did not blow it far enough. About 15 feet was the maximum effective width that could be covered by this device with one trip. The tendency to apply more dust close to the machine than at a distance was very noticeable.

By the time this stage of development had been reached the major output of the North American Cyanamide Company was required for munition purposes so the project was temporarily discontinued. Then 2,4-D arrived in Canada in 1945 and the results of that year's trials demonstrated it was so superior to any other weed killer that attention was devoted almost entirely to this new herbicide.

When experiments commenced at Ottawa in the year 1945 and completed in June 1946 demonstrated that 2,4-D could be applied in so little water that water scarcity was no longer a problem a new interest was aroused in spraying.

It was quickly realized that the turbine, the machine used to demonstrate that 2,4-D could be applied in less than 5 gallons of water per acre; would be entirely unsatisfac in these parts of Canada where fields are small and where there are diversified crops, many of them susceptible to injury from 2,4-D. Attention was then turned to the application of the idea of a low volume spray to the conventional type of boom sprayer. As a result there has been constructed a very efficient and inexpensive low pressure boom sprayer that will apply minute amounts of water per acre. This sprayer is described in Engineering Circular No. 6, copies of which may be obtained from the Field Husbandry Division, Central Experimental Farm, Ottawa.

The attractive features of this sprayer are that it operates at a low pressure, 40 to 50 pounds per square inch. This makes it possible to use an inexpensive gear pump. A pressure filter in the pipe line gives an added insurance against nozzle plugging. Overflow is taken care of very simply by a short

piece of rubber hose leading from the outlet to the intake side of the gear pump. A reliable pressure gage is an essential part of this sprayer because uniform pressure must be maintained in order to get uniform distribution of spray, and uniform distribution of a concentrated solution of 2,4-D for selective weed control is most essential in order to get satisfactory weed control without crop injury. All parts of this sprayer may be purchased by a farmer or other persons interested in spraying equipment at a cost of approximately $60.00 not including nozzles. In the diagram accompanying leaflet No. 6 all parts of this low pressure sprayer are marked and it is a simple matter to assemble these parts into the complete sprayer. A number of farmers in the Ottawa district have already done so.

Ten different types of low volume nozzles have been tested to date, others will be tested when they are available. The three most promising types tested so far are as follows:

(1) Hardie 526 B No. 2 disc .031" orifice, a solid cone nozzle.
(2) Spray systems $\frac{1}{4}$ T 650067 .029" orifice, a fan nozzle.
(3) Spray system $\frac{1}{4}$ T.L.N.N. 210 .027" orifice, a hollow cone nozzle.

The wide publicity given to the good results obtained in Western Canada in 1946 from applying 2,4-D with an atomizer on mustard in wheat naturally created considerable interest in that and somewhat similar types of applicators. It was, therefore, considered advisable to test at least one other make of this type of sprayer.

Two different makes of atomizers were, therefore, tested this year (1947) on the Central Experimental Farm at Ottawa.

Due to unfavourable weather conditions this spring, spraying for weed control was delayed until the grain was taller than is normally desirable for herbicidal spraying. It was at least 14" in height at the time these tests were made.

In these tests the machine which gave such good results at Ottawa and in Western Canada in the year 1946 gave unsatisfactory results at Ottawa this year (1947). This machine has a strong wind blast and this hurricane like blast compacted the tall grain and prevented the 2,4-D solution from hitting the weeds. This is the only explanation that can be advanced why this machine, which in 1946 killed mustard so effectively in grain that was 6" - 7" in height, failed to kill the same kinds of weeds in grain that was 14" in height in 1947.

The other type of atomizer tested uses a heating unit for atomization and partial dispersion of the vapour, wind is a further aid in dispersal. When these tests were made there was only a slight breeze. Consequently there was a good weed kill for about 15 feet away from the machine, but also severe scorching of the grain. A certain amount of the vapour seemed to disappear in the air as does steam and was not accounted for insofar as effective weed kill is concerned.

Under the conditions which these tests were made it appears that excessively fine atomization by this type of ground distributor is not very promising for weed control in field crops.

Comparative tests made under precisely the same conditions with the boom type sprayer equipped with low volume nozzles gave practically a 100 per cent control of the annual weeds present.

The Field Husbandry Division is primarily interested in the control of weeds in field crops and its efforts so far have been mainly focused on this phase of weed control. However, in recent years there has been very close co-operation between the Ontario Department of Agriculture, and the Field Husbandry Division in an attempt to solve the urgent problem of weed control on roadsides. Here it is felt that there is need for more efficient spraying equipment. The boom type sprayer that applies a large volume of water is still used. The numerous obstacles such as telephone poles, trees and mail boxes that are encountered in roadside spraying impede the use of a boom type sprayer. It was thought that the atomizer type of applicator would be more satisfactory for roadside spraying and two machines of this type were tried on a section of roadsides this year. Both of these machines gave a fairly good coverage of spray on all vegetation up to the fence and unfortunately beyond it. It would be dangerous, therefore, to use this type of sprayer for roadside spraying in districts where there are crops susceptible to 2,4-D injury growing close to the roadway. It is thought that better control of distribution may be obtained by using coarser spray. This, however, has not yet been tried.

It has already been said that for a time the Field Husbandry Division was more interested in dusting than in spraying for weed control, Attention is once more being turned to dusting as a means of applying 2,4-D. It has been demonstrated that 2,4-D can be effectively applied in the form of a concentrated liquid. It is reasonable to believe that this herbicide can also be applied as a concentrated dust. It should not be necessary to use 95 pounds of inert material in order to apply 5 pounds of 2,4-D dust. With the exception of a few laboratory tests, the Field Husbandry Division has done little towards the development of a mechanism for applying 2,4-D dust in a concentrated form. The first approach to this problem will be to try and apply air streams charged with 2,4-D dust so close to the ground that the crop which is being dusted will serve as a wind-break and prevent drifting. It is hoped that during the coming winter this idea may be embodied in a device that can be tried in the field next spring.

AFTERNOON SESSION

BUSINESS MEETING
President Noel Hanson, Chairman

REPORTS OF COMMITTEES

Research Committee

This report is embodied in the report of research abstracts, which were prepared by research workers in the conference area under the chairmanship of Mr. F. L. Timmons, Agronomist, Bureau of Plant Industry, U. S. D. A., stationed at Ft. Hays Experiment Station, Hays, Kansas. The compiled research abstracts are reproduced in one section in the back of this report and constitute the entire report of the research committee.

Report of the Committee on Herbicide Laws
By: W. L. Noe, Chairman

Your Committee on Herbicide Laws composed of Bernard C. Swenson, Tom Fitzgerald, W. F. Hall, L. W. Kephart, W. L. Klatt, Henry Lunz, C. A. Stahl, Robert H. Guntert, and Warden L. Noe, have collaborated upon the work assigned to this committee and herewith submit to the Conference the following report:

At the 1946 meeting of the North Central Weed Control Conference the Committee recommended a proposed draft of a model insecticide, fungicide, herbicide and rodenticide act more commonly referred to as the Economic Poisons or Agricultural Chemical Act. This proposed draft was adopted as a model to be followed by the Conference States in order that there be as much uniformity in weed laws of the Conference States as was practicable. Since the 1946 meeting of the Conference States the Federal Insecticide, Fungicide, Herbicide and Rodenticide Act (HR 1237) has been enacted. Three of the Conference States have during the current year enacted Economic Poisons Laws patterned after the Conference's recommended draft.

Sixteen of the forty-eight states, the Territory of Hawaii, and the Dominion of Canada, have laws regulating the distribution and sale of herbicides. An additional 22 states have laws which apply only to insecticides and fungicides. Ten of the states have no laws covering Economic Poisons or Agricultural Chemicals.

The main features of the Federal Economic Poisons Law and those laws adopted by the Conference States in 1947, are quite similar.

Your Committee believe that tabulations of the Conference States in a manner designed to show progress effected in the preparation of, and in the enactment of, economic poisons laws are desirable. Such tabulations follow:

1. ECONOMIC POISON LAWS IN CONFERENCE STATES

States With Economic Poisons Laws		Prior Unsuccessful Efforts to obtain Model Economic Poisons Law		1949 Plans for Enactment of Economic Poisons Law
*Illinois-	(1945)	Indiana	(1947)	Iowa
*Iowa-	1939	Iowa	(1947)	Michigan
Kansas-	1947	Michigan	(1947)	Nebraska
*Michigan-	1913	Missouri	(1947)	Missouri
Minnesota-	1945	Ohio	(1943)	Oklahoma
North Dakota-	1947			
*Ohio-	old			
South Dakota-	1947			
*Wisconsin-	(1943)			

*The Economic Poisons Laws in these states do not include herbicides.

2. REQUIRED REGISTRATION FEES FOR ECONOMIC POISONS IN CONFERENCE STATES

	State	Basic Fee	Additional Fee
1.	Illinois	None	None
2.	Iowa	None	None
3.	Kansas	$15 each for first 10	$5 for each over 10
4.	Michigan	None	None
5.	Minnesota	$5 each for first 5	All over 5 free
6.	North Dakota	$5 each for first 5	$1 for each over 5
7.	Ohio	$20 each-(not enforced)	None
8.	South Dakota	$5 each for first 5	$1 for each over 5
9.	Wisconsin	None	None
	Federal Law	None	None

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3. CONTROVERSIAL PROVISIONS IN ECONOMIC POISON LAWS IN CONFERENCE STATES

		1. Alternative Ingredient Statement Permitted	2. Registration of Products Registered Under Federal Act Required	3. Registration under Protest Permitted
1.	Illinois	*	No	**
2.	Iowa	No	No	**
3.	Kansas	Yes	Yes	No
4.	Michigan	No	No	No
5.	Minnesota	Yes	Yes	No
6.	North Dakota	Yes	Yes	No
7.	Ohio	*	Yes	No
8.	South Dakota	Yes	Yes	Yes
9.	Wisconsin	Yes	No	No
	Federal Law	Yes	-	Yes

* No ingredient statement required.
** No registration required.

The Conference States which have enacted laws regulating the distribution and sale of herbicides and other economic poisons, have placed the administration of such laws under the direct supervision of the following individuals:

Kansas	Paul Ijams, Director of Control Division and R. H. Guntert, Entomologist, State Board of Agriculture
Michigan	W. C. Geagley, State Chemist
Minnesota	Henry J. Hoffman, State Chemist
Ohio	George W. Owens, Assistant Chief, Division of Foods and Dairy

North Dakota R. O. Baird, State Food Commissioner
South Dakota Anton Prestwick, Director of Division of Inspection
Illinois Phillip M. Harman, Superintendent of Registration
Wisconsin E. L. Chambers, State Entomologist

Your Committee has some definite recommendations for the clarification and workability of the adopted model law.

1. We recommend that the 1946 draft of the Model Economic Poisons Law as approved by the Conference States, be amended and extended to include larvicides, ovacides, nematicides, and, other materials for control of invertebrates which are destructive, or which constitute a liability, or which may be classed as pests.

2. We feel that it is desirable that this committee be retained as a standing committee and that its membership be extended to include a representative from each of the 13 Conference States, and from the three Canadian provinces in the Conference.

Report approved by Conference.

Report of Committee on Interstate Movement of Infested Materials and Sale of Infested Material by Federal Agencies

By: T. F. Yost, Chairman

There are three distinct problems that should come under the scope of this committee which are as follows:

1. The movement of infested material crossing state lines
2. The cleaning of equipment (primarily combine harvester threshers) when crossing state lines and when crossing the U. S. - Canadian border in either direction
3. The sale of infested material by federal agencies.

The first two weed conferences had a separate committee for this latter problem, but it was decided that these two committees should be joined into one which would assume both functions.

The spread or movement of weeds from place to place is by far the most important phase of the weed problem whether it concerns the common weeds or the more serious noxious weeds. To be sure it is highly important to stamp out weeds where they exist but we believe that it is much more important to stop, to prevent or to reduce their movement from place to place. The movement or spread of weeds is usually accomplished by the transportation of weed seeds or live plant parts which may start new growth. This transportation usually takes place in the sale and exchange of farm seeds and feeds, nursery stock, the movement of farm equipment and other more minor methods. Most of the important methods of spread are man made and therefore subject to control and regulation.

The supply of 2,4-D and other organic weed killers seem to be plentiful. Mechanical equipment for applying 2,4-D is being rapidly perfected and changed to meet special conditions. Detailed information on the proper use of chemicals

as to, time and rate of application, tolerance of weed and crop plants and other important factors are being rapidly worked out by our research workers. In view of these facts it seems probable that the more common members of the weed family are going to have a tougher time of existence and of spreading from place to place than they have had in the past

It is much more serious for the seeds of the noxious weeds to spread from place to place than it is for the common ordinary weeds to do so. The noxious weeds are much more difficult to eradicate and therefore it is much more important to check or control their spread.

The spread problem is actually of equal concern to all states and provinces whether they realize it or not. States or provinces which are operating a wide scale program under legislative enactment are more actively and keenly interested, and are better able to realize the seriousness and importance of transporting materials which are infested with the seeds of noxious weeds across state lines. Any state which is spending large sums of money to counteract the ever increasing menace of noxious weeds, should have some protection to control or prevent such promiscuous movement. Any state may set up a system of their own to cope with such a situation, or it should be handled by a federal act. If a state has a port of entry system, it may be utilized to handle that part of the problem dealing with importation by commercial truckers. The movement of infested material into the state via railway shipments is much more difficult to handle.

In Kansas we are handling the importation by trucks over highways by a report and inspection system. The railroad shipments are handled by cooperation from grain exchanges and state grain inspection departments.

Any state which plans to take action against these subversive activities must first enact a state law making it unlawful to sell infested material and to require the cleaning of equipment. States which have a program to combat the menace of noxious weeds certainly have an uphill battle and with the odds against them if they are giving no attention to the movement of materials infested with noxious weeds into their state from the outside. Any state already has enough of the bad weeds without having more brought in by indiscriminate and careless shippers and commercial operators. Since most states are almost helpless to cope with the problem of interstate movement of weed infested materials it should be made a federal violation in conformity with state laws.

The operation of transient custom combines through the west central states from Texas through Oklahoma, Kansas, Colorado, Nebraska, Wyoming, Montana, South and North Dakota and thence into Canada has become a big industry. This industry has grown from infancy to its present gigantic size in a short period of only about ten years. This activity has been and is of great assistance to the wheat producers in this area during the war period when machinery supplies have been acute. Only few people realize what this giant industry is doing to help aggravate and spread the menace of our bad weeds. This great wheat producing area at the present time has only a small acreage of bindweed or other perennial noxious weeds, but the time is not far in the future when this area will become heavily infested with perennial noxious weeds unless something is done to regulate this industry in the cleaning of their machines before crossing state lines, and before moving from infested farms.

The states to the south are certain of having more and more Canada thistle, sowthistle, leafy spurge and hoary cress brought to their highways and farms by custom combines moving from the north where these weeds are commonly found in wheat fields. Similarly the states and provinces to the north are sure to inherit more and more bindweed in their wheat producing lands from the states further south. This is a vicious circle which operates from north to south in April and May and from south to north during June, July, and August. It is to the interest and well being of all the states and provinces concerned to join hands in working out a solution to this complicated and perplexing problem.

The third problem of serious concern to all states involves federal agencies and programs who make it their business to enter into the merchandising field to help alleviate a temporary or emergency condition. For the purpose of this discussion we do not care to criticize the merchandising angle of such agencies, however we think that such procedure should conform to existing state laws. To explain, we will refer to the AAA farm program which was in operation for about ten or twelve years, and which now is operating as the production and marketing administration. During a period of three or four years extending from 1940 to 1944 in Kansas alone this agency sold 6,935,015 bushels of wheat for feed to farmers with no regard to the presence of noxious weed seeds. It goes without contradiction that this one activity alone has and will start tens of thousands of bindweed infestations. We fully believe that the damage done to the farmers and landowners of the state is far greater than the service rendered. We have heard that other states were confronted with the same or similar problems. Such activities are not in progress at this time but it is entirely probable that they will return when drouths, hard times, and low prices come back again.

The intention of this prepared statement by myself is not given as a committee report, but more as a statement to call to your attention the serious nature of these problems which I have discussed. Those of you who are interested in these problems should also read the report given by C. H. Schrader of Minnesota, which is reported on page 131 of the proceedings of the Des Moines meeting in December of 1946.

May I urge that the conference president for the coming year continue the activities of this committee, and that the subject be given some prominence on next year's program. This committee should also include the problem of dealing with federal agencies in the handling, transporting or sale of any materials which may be infested with noxious weeds.

Report approved by Conference.

Report of Committee on Extension Activities
E. P. Sylwester, Chairman

About six weeks ago I contacted all members of the Committee on Extension Activities and asked them to submit reports concerning the most outstanding accomplishments in weed control Extension during the past year. I asked these committee members to limit their report to approximately one page. This may have worked an undue hardship on certain states where an extremely active program has

been underway. Certainly no state was given opportunity to discuss their program in detail.

OHIO

D. F. Beard, Extension Agronomist
and
C. J. Willard, Associate in Agronomy

D. F. Beard reported that there had been no special Extension program on weeds this year. Dr. Beard put on a demonstration of pre-emergence treatment of corn at the field meeting of the Ohio Hybrid Seed Corn Producers. Some 500 people saw this demonstration. Between 300 and 400 people saw a very striking demonstration on the Agronomy plots at the time of the meeting of the American Soybean Association at Columbus. Corn was planted August 1 in very weedy ground, some of it treated with 2,4-D at various rates and some of it not treated. County Agents in at least two counties have had weed control meetings without the attendance of anyone from the University. C. J. Willard gave a talk on weed control at a meeting of the City Farmers Club in Van Wert early this year.

INDIANA

Oliver C. Lee, Extension Botanist

Information relative to new developments in weed control were summarized at the early part of the year. A leaflet, "How to Use 2,4-D to Kill Weeds" was published and distributed through the County Agricultural Agents and supplied upon request to individuals writing for information on this subject. Some 20,000 copies of this publication were distributed during the spring and summer. This publication explained how to use 2,4-D to kill various types of weeds in Indiana. It listed ninety-eight weeds on which 2,4-D had been used, classifying them as susceptible, intermediate, and resistant.

During March the writer attended nine district meetings at various points in the state to discuss the use of 2,4-D as a weed eradicant with County Agricultural Agents and other County Agricultural leaders. Plans were made at this time for demonstration fields that could be used to illustrate methods of application of 2,4-D as well as show results. At this time, County Agents were asked to encourage individuals who might be interested, to purchase spray equipment and plan to do custom spraying. This appeared essential in order to get the job of spraying done as the shortage and the high cost of spray equipment made it prohibitive for individual farmers to obtain sprayers. It is estimated that some four hundred custom spray rigs were made available for custom work. Schools were held for those planning to operate these machines, giving them instructions in the type of equipment and nozzles to use and how to apply 2,4-D on various types of weeds. This was followed with personal assistance given to spray operators in the field at which time farmers were asked to see the operation of these sprayers and at the same time contract with the spray operators for spraying on their own farms.

Because of the abundance of rainfall during the corn planting season and immediately following, an acute weed problem arose, especially in the river bottom areas of the state. Cultivation was impossible because of wet fields, making it necessary to take more drastic steps to save the corn crops. Because of lack of information on the use of 2,4-D on corn, emergency demonstra-

tions were held to show effects. As a result, several thousand acres of corn were sprayed. Although all of the yields have not been checked to date, it is evident that spraying saved many a corn field and those fields which appeared to be doomed because of weeds are now yielding from fifty to eighty bushels per acre.

Four demonstration fields were established in the state to demonstrate the merit of spraying with 2,4-D to control weeds in corn. These fields were used to show the actual results of spraying at various stages of corn growth and the effect it had upon the corn plants, as well as weed growth. The subject of chemical weed control was discussed at all large field meetings, including such meetings as the Southwestern Indiana Field Day, three Field Days held at the University and other miscellaneous meetings.

MICHIGAN

B. H. Grigsby, Research and Associate Professor of Botany

1. Discussions on weed control practices at grower's meetings.

   a. County-wide meetings in cooperation with county agricultural agents - 5 meetings with average attendance of 50 growers at each.

   b. All day spraying demonstrations. Five days with four county agents. Three additional days spent in observing and discussing results obtained.

   c. Annual Meetings

      (1) Muck farmers Association
      (2) Canner's Association
      (3) Seed Grower's Association
      (4) Fruit Grower's Association
      (5) Institutional Gardener's Group
      (6) Rural Minister's Conference
      (7) Leaders of Vocational Agriculture
      (8) Lawn and Turf Association

      Brief discussion of recommended practices and research in progress given at each of these meetings.

2. Radio Programs. Five 15-minute programs on specific phases of weed control in grains, vegetables and public health (ragweed and poison ivy).

3. Newspaper releases. Seasonal notices of time and materials to be used for specific weed problems.

4. Demonstration spraying for control of ragweed and poison ivy on public and city property. Two day program in one county. Cooperative project with Michigan Department of Health, local garden club and County Agent.

5. Weed control materia[l] prepared:

5 quarterly bul[l]etin articles
1 mimeograph se[r]ies on 2,4-D
1 Extension folc[e]r on weed control for resort areas
1 Set Kodachrom[e] slides on ragweed control
Annual survey of pollen count during hayfever season (Michigan Department of Health).

6. Information to County Agents on a regional basis in conjunction with other meetings. Also to commercial units operating lawn and turf weed control units.

NORTH DAKOTA

L. A. Jensen, Extension Agronomist

Statistics.	County Agent Training Meetings (2) attendance	140
	Assisting with county meetings (10) attendance	860
	County reports not yet available. Nearly all counties have done some work on this program.	
	Estimated commercially owned spray or dusting units	150
	Estimated individually owned spray or dusting units	120

Cooperation. Production and Marketing Administration made payments for the application of sodium chlorate, Borascu and 2,4-D on field bindweed, Canadian thistle, and sow thistle and for the use of chlorate and Borascu only on leafy spurge, perennial peppergrass and Russian knapweed. Payments were also made for control by cultivation of field bindweed, perennial peppergrass, leafy spurge, Russian knapweed, Canadian thistle, sow thistle and for eradication of quackgrass. The Soil Conservation Service has also worked on weed control as a part of the local district program. Several local districts have been particularly active.

Weed Control Material Prepared. Three new circulars have been added this year.

Circular A-105 - Controlling Annual Weeds by Tillage and Cropping Practices - Extension Agronomist
Circular A-108 - 2,4-D For Weed Control - Extension Agronomist
Circular AE-23 - Build Your Own Farm Sprayer - Ag. Engineers

Results. A survey of County Extension Agents indicated the following estimated acres of weeds treated with 2,4-D and Dinitro chemicals in 1947:

1. 2,4-D used

A - Acres of small grains treated

Spray rigs	76,783	
Ground driven dusters	23,480	
Airplane application	17,350	
Total		117,613

Kind of crop treated showed wheat 2%. barley 20%, oats 8%

B - Acres of weeds treated not in small grain crop

Creeping Jenny (Field bindweed)	2,885	
Canada thistle	700	
Sow thistle	882	
Other perennials	206	
Annual weeds	1,678	
Total		6,351
Total of all 2,4-D acres treated		123,964

All counties except one indicated there would be an increased number of acres treated with 2,4-D next year. In my opinion there were more nearly 140,000 acres of crop treated with 2,4-D than the figure indicated by this report.

2. Acres of crop treated with Sinox or Dow Selective

Flax	34,950	
Peas	100	
Small grains	23,700	
Total		58,750
Grand total all acres treated		182,714

There was also shipped into the state and distributed, largely through County Extension Agents, Sodium Chlorate 339,900 pounds, Atlacide 81,400 pounds and Borascu 63,300 pounds. If properly applied at recommended rates these chemicals would cover 655 acres.

Plans for 1948. There is a strong demand from farmers for information on small inexpensive homemade or commercial spray rigs. It is our intent with the use of Circular AE-23 to encourage individual farmers to own spray equipment but at the same time not to discourage commercial operators. We will continue our efforts to get out the latest information on the use of chemicals and other methods of Weed Control.

OKLAHOMA

Clyde A. Bower, Ent. & Plant Ind. Div., State Dept. Agr.

Our work has been confined to bindweed principally in Northwestern Oklahoma. We have a total of thirteen meetings at which time demonstrations were also given as to control measures by the use of a power sprayer. These meetings and demonstrations were attended by 624 people. Our department operates a considerable number of power sprayers on a custom basis. During the past year fifteen of these have sprayed approximately one thousand acres of bindweed with 2,4-D as an aid to control. We estimate there are at least fifty power sprayers which are privately owned that have sprayed bindweed during the past season. These units are similar to ours in that they are combination livestock and weed spray machines. We find that we can spray bindweed for about a month and a half during the spring and then again for about two months in the fall. Our best results have been on wheat land which has been forced out of production by bindweed. The farmer prepares his seed bed and drills his wheat just as if the bindweed were not present.

Approximately three weeks after the wheat is up and the bindweed is likewise making vigorous growth, we spray the fields. The bindweed is retarded to such an extent that a profitable wheat crop can be harvested the next spring. By following this procedure it will be necessary for the bindweed to be sprayed each year.

Another use to which we have applied our spray trucks is for brush control. We have one series of plots where various forms of 2,4-D were applied with a power sprayer to such growth as persimmon, hickory, elm, sumac, and oak. The results have not been too satisfactory, and we are awaiting next spring to determine how much growth will reappear.

In Northwestern Oklahoma, at the present time, there is considerable interest in the application of 2,4-D to sage brush from airplanes. It is our understanding that a flying concern from California has contracted approximately forty thousand acres on the Oklahoma-Texas border to be sprayed next season. Preliminary experiments along this line were conducted this past year.

MISSOURI

J. Ross Fleetwood, Extension Specialist in Field Crops

The educational activities of the Agricultural Extension Service in weed control work is still confined to pure seed work and the use of sodium chlorate on bindweed and Johnson grass, but more emphasis has been placed upon the place of 2,4-D in weed control.

In addition to demonstrations of 2,4-D in weed control on lawns, in fence rows, and in growing crops, some demonstrations were set up using Ammate and 2,4-D on sprout control. There are thousands of acres of land in the Ozarks area where the control of sprouts is the first essential in pasture improvement.

Information on the latest recommendations and results from 2,4-D was sent to county agents as needed during the year. The early, wet season caused a great deal of weedy corn. A large number of growers sprayed corn with 2,4-D at various stages of growth with, on the whole surprisingly good results.

The demonstrations on 2,4-D have been general enough that a number of commercial or contract sprayers will be operated in 1948.

IOWA

E. P. Sylwester, Extension Botanist & Plant Pathologist

The weed control program in Iowa is based on education. However, our last legislative session has amended our weed law to the extent that if it becomes necessary to enforce the provisions of the law it can very easily be done. If enforcement becomes necessary, the titled owner of the land bears the expense. The weed law provides for a county weed commissioner, for an enabling levy for weed control work, for an enabling levy for roadside brush control work, and for purchase of county owned weed eradicating (spraying) equipment. The weed law enforcement in each individual county is up to the county weed commissioner, acting under the board of supervisors. The swing to county weed commissioners has been slow, due to absence of suitable personnel. Last year 50 counties operated under the county weed commissioner plan. Even in counties where active weed control programs are in action, enforcement has been necessary in only

a few instances. This is because the entire program is based on education, with enforcement used as a last measure. Cooperation between the State Department of Agriculture, The Extension Service, and the Experiment Station are excellent. The State Department of Agriculture has charge of the regulatory work, the Experiment Station conducts the research work, and the Extension Service the educational work.

In an educational way, the specialist in the Extension Service devoted full time to helping counties organize better weed control activities. There were individual weed meetings held in 45 counties. There were 42 days spent in state and district time at which time at regional field days, most of our 99 counties secured additional help on weed control. In all, the specialist attended 183 meetings of all types, night schools, demonstrations, open county meetings, supervisory board meetings, etc. The total attendance at all meetings where weed control was discussed was 18,201. There were 77 individual farm visits to problem areas, 18 radio talks on weeds and 20 press articles on weed control. These latter are written up for newspaper use but are also reworked by our Publicity Department for use in county agent news releases and radio work. Five new leaflets on weed control were prepared, one cooperative bulletin with the State Department of Agriculture is in press, and two reprints in "Farm Science" were extensively used in meetings and correspondence to the extent of 40,000 copies of each reprint. There were 2,117 first-class letters written in response to inquiries concerning weed control. A Kodachrome chemical weed control set of 150 slides was completed. Exhibits on weed control were sponsored at the State Fair Dairy Cattle Congress and by means of the Extension "Caravan."

Never has interest in weed control been so high. Many hundreds of acres of oats, flax, and corn were sprayed for weed control this year. Our most effective teaching method has been the demonstration type, where for 20-45 minutes on field days, or at special meetings, we demonstrated our small portable inexpensive sprayer. Tractor attachment units are becoming extremely popular. In one county, there are now 50 such units, in another 200 where there wasn't one a year ago. There are several companies in Iowa making these units at the present time. However, the surface has barely been scratched. We believe that as soon as these inexpensive trailer or tractor units become plentiful, they will be standard equipment on every farm. In addition, we have record of at least 375 custom sprayer operators in Iowa now, where 2 years ago, we had less than 50. The growth of individual home units and custom spraying has been phenomenal. We have two airplane companies doing aerial spraying. Altogether about 10,000 acres of pasture and corn land was sprayed for weed control by these two companies. About 50,000 additional acres of corn were sprayed with ground equipment by commercial operators. No figures are available on individual amounts sprayed by individual farmers but thousands of acres were treated. Practically all of our counties now have some type of spraying equipment for roadsides, much of it modern equipment which was purchased this past season. Others will have modern equipment shortly. We feel that our program is finally functioning very well, and that we now are really making progress and capitalizing on the many years of educational work which we have promoted.

MINNESOTA

Sig Bjerken, Supr. Weed Insp. Div. Weed & Seed Control, State Dept.

The Weed and Seed Division of the Bureau of Plant Industry, State Department of Agriculture, Dairy and Food is in charge of and responsible for the enforcement

of the Weed and Seed Laws of the State of Minnesota. Weed inspection and control in Minnesota falls under the supervision of three groups - namely, local, county, and state. The law provides that the three township board members and mayor of villages and cities are the local inspectors. Their duties are to check all parcels of land under their jurisdiction and to cause weeds to be destroyed in the manner they specify. When requested by the Commissioner of Agriculture, county boards shall appoint a county weed and seed inspector to supervise the local inspection and to assist district inspectors.

The state is divided into eight districts and each district has one inspector who devotes six months organizing, assisting and supervising the weed work of the county inspectors. The remaining six months are devoted to checking seeds, feeds, and fertilizers offered for sale in the state. Our state office staff consists of the weed supervisor, seed supervisor, agronomist and a state inspector, all under the Director of the Bureau of Plant Industry. This gives the state a well organized and supervised program, which has resulted in an estimated 90% control of field bindweed and leafy spruge in the state.

The State Department of Agriculture cooperates very closely with the University Extension Division. This has proved very advantageous in carrying out the educational part of the weed and seed program. I would summarize our 1947 program as follows:

1.	Counties in the State of Minnesota	87
2.	Counties appointing one or more county weed and seed inspectors	83
3.	Townships in the state	1,876
4.	Inspectors checking said townships	5,628
5.	Cities and villages in the state, each having an inspector	752
6.	District inspectors	8
7.	Seed, feed and fertilizer inspections made	3,029
8.	Annual Pest Conferences held	93
9.	Attendance at these conferences	4,756
10.	Educational weed exhibits at county fairs	87
11.	Other exhibits (State Fair and Crookston Winter Show)	2
12.	Acres of field bindweed (estimate)	125,000
13.	Acres of leafy spurge (estimate)	35,000
14.	Pounds sodium chlorate used, estimated	1,500,000#
15.	Pounds of Borascu used, estimated	1,250,000#
16.	Number of acres treated with 2,4-D, estimated	400,000
17.	Fargo power sprayers in the state	367
18.	Other power sprayers (estimate)	540
19	Custom sprayers (estimate)	60

WISCONSIN

George M. Briggs, Extension Agronomist

Methods Used. Follow up with all counties and particularly with those that had selected weed control as a major activity.

1. Publications

a. Special circular on "Low pressure spray outfits" and "Use of 2,4-D" in weed control.

b. By "Weed Flashes" current issue mimeograph to all county agents about four times yearly keeping agents up to date on what's doing in various counties, plans for future, high points in equipment and material.

c. Answered weed control inquiries through agricultural college press releases.

d. Took part in radio topic twice monthly APril to October over local radio station.

e. Article published in Wisconsin Farm Bureau News.

2. Demonstrations

Four counties held field meetings where various types of spray outfits were brought together. Such as those used for custom work, private and cooperative use and outfits owned by couhties and townships. Also demonstrated spray outfit assembled and mounted on trailer and equipped with various gadgets and proper explanatory material.

At Grassland Field Days where from 500 to 800 farmers attended, giving discussion and demonstration on equipment and materials for effective weed control.

Many counties with county agent held demonstration meetings in various parts of county applying chemical to different weeds.

In conjunction with 7th and 8th graders, eight demonstrations in one county.

At Farmers Field Day at University and Branch Experiment Stations at four locations held weed clinic and gave spray demonstrations and discussions.

Meetings. Gave weed topic at meetings in fifty counties. Assisted State Weed Commissioner at eight county meetings of county weed commissioners. Held conference of agricultural committees in few counties to outline a weed control procedure.

Contacts. Members of Agricultural Engineering Department, manufacturers of spray equipment and spray materials, county and township administrative force, G.I. trainers, state and county seed and feed dealers.

Results. Four manufacturers of low pressure outfits with sales organizations within state. Many local sales organizations set up. One large Fargo sprayer brought into state for applying dinitro products as well as 2,4-D. Many townships purchasing equipment and materials for use by farmers within township.

Many farmers privately and cooperatively purchasing small outfits for operating by tractor and small motors.

Several feed and seed dealers, among them some co-op stores, have spray equipment for use in community.

A continued interest by some townships on payment of partial cost of materials and equipment for spraying.

While 2,4-D application accepted as AAA farm practice, few counties accepted dinitro application.

Exhibits at county and local fairs very common of weed spray equipment and results of 2,4-D and dinitro products by county agents and vocational agricultural teachers.

More and more materials being handled and used.

More and more equipment, regular and home built, being used, 300 being the greatest number of outfits in any one county.

NEBRASKA

Loys F. Smith, State Weed Supr., Department of Agriculture
Noel S. Hanson, Asst. Agronomist
John D. Furrer, Ext. Weed Specialist

Summary of Activities Relative to Weed Control of the Division of Noxious Weeds, Nebraska State Department of Agriculture; the Extension Service, University of Nebraska; and Department of Agronomy, University of Nebraska.

The number of organized weed districts in the state of Nebraska increased from 72 to 85 during the year. During the first eleven months of 1947, 127 educational meetings were attended by 3,400 individuals; 20 organizational meetings of weed districts were attended by about 500; 31 demonstrations of spray equipment and methods attracted 775 people; 75 annual meetings of the weed districts had a total attendance of 1,500; 45 farmers were present on two planned tours; two meetings of the State Weed Advisory Committee for the Division of Noxious Weeds were attended by twenty members; approximately 500 attended the State Weed Conference held in conjunction with an equipment and chemical show; personnel of the various weed departments were invited and participated in 59 additional meetings attended by an estimated 2,950; 18 fair exhibits were viewed by about 9,000 people.

In 1946 there were 24 farmer-owned sprayers in the state; 1947 saw this number increase to 250. The 250 farmer-owned machines treated approximately 25,000 acres for weed control. There are at present 40 commercially owned sprayers in the state. The noxious weed districts own 100 machines. These district machines sprayed about 25,000 acres of noxious weeds during 1947; kills ranged between 50 and 99 per cent.

An estimated 50,000 or more acres of corn in Nebraska were treated with 2,4-D for control of weeds such as cocklebur, sunflower, pigweed, velvetleaf, and bindweed. Of this acreage, about 1,800 acres were treated by airplane.

Publications pertaining to weeds and their control are Extension Circular 172, Recommendations For the Use of 2,4-D for Weed Control in Nebraska in 1947; Agronomy Department Circular #81, Method of Calibration of Weed Spraying Equipment; Information Series #27 and #28 and how to build homemade sprayers for 2,4-D; a Weed Fact sheet which contained pertinent information relative to the seriousness of weeds in Nebraska; a pamphlet on activities of the Division of Noxious Weeds of the State Department of Agriculture; and the Department of Agriculture and Inspection Bulletin #101, Nebraska Weeds, was revised.

A "Nebraska War on Weeds" educational program designed to supplement the activities of the Division of Noxious Weeds has been undertaken. The aims of the program are (1) to acquaint the citizens of the state with the seriousness of the weed situation and to make everyone more weed conscious, and (2) to disseminate through press and radio timely information on weed control. The War on Weeds Board is set up with the Governor as honorary chairman. The Executive Board is headed by the Director of the Extension Service. who was elected as chairman. In addition, the organization includes Advisory, Technical, Finance, and Public Information Divisions. The program has been set up with educational and recognition features. Educational features include courses of study in the public schools, the encouragement of individuals to make weed collections, reorganization of weed 4-H clubs, and identification contests. Recognition of farmers and municipalities that do outstanding work in weed control is planned.

SOUTH DAKOTA

U. J. Norgaard and Elmer Sanderson, Extension Agronomists

Summary of South Dakota Extension Service Weed Control Activities - 1947.

The State Extension Agronomy Specialists and County Extension Agents have taken a very active participation in the South Dakota weed control program during 1947. To date 45 counties have County Weed Boards elected and have an organized county weed control program in action. County Agents, according to the South Dakota program are responsible for assisting in the organizational work and conducting the educational phase of the program. According to county reports and others assisting in weed control, approximately 270 weed meetings were held throughout the state with an estimated attendance of 8,500.

Each of the 50 counties in South Dakota having a County Agent, of which there are 50, received an army surplus sprayer. These sprayers were equipped by the counties with weed spraying facilities and County Agents in all counties used them in conducting weed spraying demonstrations. In addition to patch and field demonstrations, considerable spraying was done on road-side weed control, both for noxious and annual weeds.

Demonstrations by the Extension Service were extensive throughout the state. In one northcentral county the county agent and County Weed Board arranged and held a weed control demonstration in each of the 40 townships in the county. These demonstrations showed the different types of spraying equipment, how weeds should be sprayed, and the various weed chemicals.

The State Weed Board, with the assistance of the Extension Agronomists held four state district meetings. County Weed Boards, County Commissioners, and County Agents were in attendance. These meetings were held in order to supply information relative to state policies, organization procedure and allow these leaders to get suggestions and ideas from each other.

The Extension Service sponsored a two day weed school and chemical and equipment show, which was well attended. County Agents, County Weed Boards, County commissioners, commercial spray operators, were in attendance. Commercial concerns cooperated in putting on the chemical and equipment show.

The Extension Service assisted the counties by preparing information and educational material. In cooperation with the Agronomy Department, a list of 2,4-D and dinitro compounds was prepared for use by County Agents, P.M.A. officers and others. This outline gave pertinent information relative to the various 2,4-D compounds offered for sale and the amount of each compound needed per acre in order to apply the recommended amount of 2,4-D acid per acre.

At outline of organization procedure and with definite responsibilities designated for elected weed control leaders was prepared for county use. Four color pictures of noxious weeds, namely: creeping Jenny, perennial sow thistle, perennial peppergrass and leafy spurge, have been printed and distributed by the County Agents. Four other noxious weeds; Canada thistle, Russian knapweed, quackgrass and horse nettle are being printed and will be ready for distribution in 1948.

A very brief outline in chart form on the chemical and cultural control of weeds has been prepared. In the South Dakota weed program every farmer will receive a map on which he will be asked to show his noxious weed infestations and also to indicate how he plans to control them. This outline will be of assistance to the farmers in helping them to determine what control method to use.

In cooperation with the Agronomy Department, the Extension Service prepared several sets of about 35 color 2 x 2 picture slides on weed control. A narrative was prepared, giving pertinent information about each slide. Many counties purchased these color picture slides for use for their educational meetings.

The 1947 legislature appropriated $54,900 for the administration of the state weed control program. From this fund, which came available July 1, 1947, the State Weed Board was able to employ W. L. Klatt, State Weed Supervisor and Chas. J. Gilbert, Associate Weed Supervisor. The State Weed Board has its office and headquarters at Brookings, South Dakota with the above personnel in charge.

Thirty-two counties in South Dakota made a total appropriation of $130,000 for administering their programs in 1948.

Many custom operators were in operation during 1947, especially in the eastern counties. Because of the relative short time for optimum weed spraying in South Dakota, it is the opinion of many that the small, inexpensive individual farmer sprayer will be most practical. Farmers can then spray weeds when they should be sprayed and will also be able to kill weeds cheaper.

ILLINOIS

Chas. Keltner, Illinois Secretary of Agriculture

University of Illinois. Contact with the farm population of this State has been through field days on the University Farm, where thousands of visitors have been told about weeds and weed control through culture and chemicals. Hundreds of specimens of weeds have been received by the Agronomy Department and identified. Accompanying the identifications have been recommendations concerning the best

control measures. At the Dixon Springs Station in southern Illinois, over five thousand visitors received information on the mowing and the spraying of weeds. Weed control was also discussed at connty pasture improvement meetings.

Department of Agriculture. More specimens of weeds were submitted to this department for identification than in any previous similar period in the history of the same. When perennial weeds were received, the sender's attention was called to the importance of immediate control measures. Representatives of the Department of Agriculture cooperated with the Extension Service of the College of Agriculture in conducting county weed control meetings; also in a series of county pasture improvement meetings.

Weed control was given proper consideration in the preparation of the Department of Agriculture exhibit for the state and county fairs. Additional attention to this subject was evident in the Department's exhibit at the International Livestock Exposition, Chicago.

The 65th General Assembly amended the state noxious weed law so as to provide counties with the authority to adopt noxious weed control programs and finance the same. In the same session, the Department of Agriculture was given the right to quarantine patches of leafy spurge and hoary cress. The legislature also limited the weed seed content of commercial feed mixtures and required that these seeds be devitalized.

KANSAS

J. W. Zahnley, Professor of Crops

The Extension phase of the weed control program in Kansas is carried on largely as a part of the soil management and crop production project under the leadership of the three extension workers in Agronomy. These men work through the county agents and cooperate with the county weed supervisors in guiding the farmers in the solution of their weed control problems. Expressed long-time goals are (1) to teach every farmer to know the noxious weeds of his county and the methods of control, and (2) to teach 4-H Club members to identify the important weeds in their locality and how to control them.

In 1946 there were 2,346 demonstrations on weed control conducted in the various counties of the state, and 18,686 farmers were following recommended methods for the control of noxious weeds. Field bindweed was destroyed on 10,340 acres. This is a part of the noxious weed work conducted on the County level and supervised by the state program against noxious weeds.

A total of 867 spray demonstrations and 1,114 cultivation demonstrations were reported from 44 and 58 counties, respectively. Many of the county agents and weed supervisors have been active in demonstrating the use of 2,4-D for the control of weeds and brush in pastures, along roadsides and in cultivated land. Control of weeds in lawns was widely practiced last year as a result of demonstrations carried on in 1945. In the fall of 1947 a large number of tests have been started to show the effect of fall applications of 2,4-D for controlling weeds in spring planted crops. Applications of the chemical were made on the fall growth of bindweed on land which is to be planted to crop next spring.

Although Kansas has no full-time extension specialist assigned to the weed control project, the county agents and county weed supervisors are cooperating

with farmers and extension crop specialists in carrying out an effective educational program in weed control.

The above constitutes the report of the Committee on Extension activities. The following suggestions are respectfully submitted as recommendations for the consideration of the officers of the Conference for next year.

1. That State Extension workers be given a specific, brief time on the general conference program, to discuss the most important educational activities and procedures which they have found effective in the several states.

2. That overlapping of membership in this committee be avoided as far as possible since membership in many committees makes it impossible for members to attend meetings of this committee.

3. That brief reports of state activities be published as heretofore since it enables extension workers to see what methods are in use and most effective in other states.

4. That in addition to the reports of the past years activities, there also be included in these reports, an outline of plans to be used in the following years educational activities in weed control.

The report was approved.

UNIFORM STATE WEED AND SEED LAWS

By: Clyde Spry, Chairman

Uniform laws in the several states in the conference should first take into consideration the need for the several state legislatures to enact a shall instead of a may program for weed control.

These laws should set out the responsibility of the state and local enforcement agencies.

Each state should properly finance the program so as to make effective control possible on a state wide basis. They should also enact legislation that will make it possible to levy taxes as will provide proper control on all lands within the taxing districts.

It shall be the duty of the public agency whose duty it is to maintain the road system in each state and its subdivisions to take over the entire weed control and eradication program on such roads between the fence lines or that portion which is donated for general use.

The weed control work should be coordinated with seed control if we are to stop the spread of noxious weeds. It is very inconsistant to try to control and eradicate weeds, which we continue to sow in our crops each year.

The laws of several states should be revised to control the sale and move-

ment of whole grain and other materials that are infested with noxious weeds.

The present committee recommends that - The Committee that will have uniform weed laws for consideration for the 1948 session draft a proposed uniform law that will cover the field of weed control for presentation to the next conference.

REPORT OF THE COMMITTEE ON RESOLUTIONS
By: W. L. Klatt, Chairman

The North Central Weed Control Conference assembled in Topeka, Kansas, December 10, 11, and 12, rededicates itself to fuller realization of the purpose for which it was established.

The healthy growth in interest in all phases of weed control and eradication, and the past year are matters in which this conference is recognized as having a major part.

WHEREAS, The weed problem is a serious menace in all sections of the United States and Canada, and affects the well being of all classes of people, and

WHEREAS, The North Central Weed Control Conference consists of personnel in the various states, United States Department of Agriculture, Provinces of Canada, Dominion Experimental Farms, and commercial organizations.

WHEREAS, At this time in the face of a world wide food crisis, in which weeds and woody plants are leading saboteurs in all agricultural crops including range and pasture lands, and

WHEREAS, Weed free pastures will contribute to the savings of grain and augment the world food supply, eliminating losses in much needed food products, and

WHEREAS, There is a lack of adequate trained personnel in weed control work,

BE IT RESOLVED:

1. That every effort be made by all agencies and individuals concerned to continue and expand the worthwhile research, extension and regulatory activities so that losses in food, due to weeds, be curtailed as quickly as possible.

2. That every effort be made to support the training of additional personnel to take active roles in the various phases of weed control program, including educational, regulatory and research activities.

3. That our Senators and Representatives in Congress and State Legislative bodies be kept fully informed of the importance of weed control through a continuous educational and publicity program.

4. To commend all our research workers including state, federal, Canadian, and commercial for their cooperation and painstaking effort in

making it possible to advance the ideals for which this conference is working and enabling the educational service and regulatory agencies to better accomplish their purposes.

5. That a vote of thanks be extended to our host state, Kansas; and to the city of Topeka; and especially to Governor Frank Carlson; Secretary of Agriculture, J. C. Mohler; Mayor Warren; The Chamber of Commerce; and other city officials for placing the facilities, of the Municipal Auditorium at our disposal; also to T. F. Yost, and his local committee; the officials of the conference and the program committee for a splendid program and arrangements.

That additional recognition is due to L. W. Kephart and Carl S. Quisenbury, both of the United States Department of Agriculture; to L. E. Kirk, Director, Plant Science, Food and Agriculture, United Nations; to Mr. F. L. Timmons, chairman of the research committee, for their untiring efforts in organizing, executing and presenting their material.

That thanks be extended to all commercial concerns who have generously contributed to the support of the conference and supplied splendid educational exhibits. Thanks is also due to the Topeka chapter of the S. P. E. B. S. Q. S. A. Thanks is also due to Gene Spratt in charge of radio and publicity, to all radio stations and newspapers, especially the Topeka Capital, Topeka State Journal, and Radio Station WIBW. Also to the hotels for accommodations, to our toastmasters and after dinner speakers, to our discussion leaders and all others who helped make this program a success.

Approved by Conference.

REPORT OF POLICY COMMITTEE

By: Dr. C. J. Willard, Professor of Agronomy,
The Ohio State University, Vice-President of the Conference

Dr. Willard had copies of the tentative Policy Committee Report distributed to all in the room. He introduced it with the statement in the Introduction, that it definitely was not intended to replace State and local directions.

Then, under his chairmanship the group went over the report section by section. Many sections passed without comment from the floor, but several sections, notably A-7, B-4, C, E, and G-2 evoked considerable comment. Most of these sections were revised by the Committee in the light of these discussions. The revised report follows:

REPORT OF POLICY COMMITTEE ON HERBICIDES

Introduction. This report of the Policy Committee on Herbicides of the North Central Weed Control Conference represents our best combined opinion concerning the value of different herbicides for different plants and conditions. The effectiveness of herbicides depends on so many factors which vary so greatly from region to region, that this report can in no way replace state and local

recommendations. These can and should be made more definite than is possible in a report covering the wide area that this does.

A. Herbicides other than 2,4-D

1. Sodium chlorate

Sodium chlorate and proprietary mixtures based on it are recommended for the treatment of small areas of perennial weeds where a quick knockout and complete eradication are desired and where soil sterility for more than two or three years is not objectionable even at high cost. The use of sodium chlorate is not desirable where temporary soil sterility would result in serious soil erosion, the elimination of an established stand of perennial grass, or the loss of several garden or other high value crops. In such cases treatment with 2,4-D or a combination of 2,4-D treatment and intensive cultivation are considered advisable even though complete eradication may require a longer time.

2. Dinitro herbicides

With the development of 2,4-D as an efficient selective herbicide for the control of annual weeds in tolerant crops, recommendations for use of the several dinitro herbicides is limited to the following practices:

(1) For the control of annual weeds in crops sensitive to 2,4-D, such as flax, canning peas, field peas, new seedings of alfalfa, etc., the ammonium salts of the dinitros are recommended as per manufacturers' schedules.

(2) For quick temporary elimination of herbaceous or grassy weed growth along highways, railroads, fence rows, canals and similar situations, the use of concentrated dinitro herbicides applied in oil, or oil and water emulsions.

(3) For the elimination of nimblewill spots in bluegrass lawns.

(4) The dinitros have been used in seeded onions, but the effects are determined by weather conditions at the time of spraying to such an extent that general recommendations for their use in onions are not advisable at this time.

3. Borax may be used:

(1) For the control of susceptible herbaceous perennial weeds on non-crop land, where soil sterility is not an important consideration.

(2) As an efficient herbicide for the elimination of leafy spurge and dogbane. Applications of 15 and 20 pounds per square rod respectively are recommended.

(3) For semi-permanent elimination of herbaceous weeds and grasses on areas bordering petroleum installations, arsenals, warehouses and other situations where vegetative material constitutes a fire hazard. Use at least twenty pounds borax, or twenty pounds borax plus two to three pounds of sodium chlorate, per square rod.

4. Ammonium sulfamate

The use of ammonium sulfamate (Ammate) for the control of herbaceous perennial weeds and grasses has been proven inefficient. Specific recommendations for uses of this material are:

(1) For quick elimination of woody shrubs, particularly the shrubby form of poison ivy, as a foliage spray, or as the dry salt at three to five pounds per square rod.

(2) For killing of tree stumps and elimination of sprouts, along highways, under power and communication transmission lines. Applied to freshly cut stumps, 2 to 4 ounces of the dry salt for each six inches of diameter of the cut stump, or to freshly cut surfaces of stump sprouts, elimination of sprouts and rapid disintegration of stumps ensues.

5. Isopropyl-N-phenyl Carbamate

Isopropyl-N-phenyl carbamate (IPC) has generally given only disappointing results in the control of perennial grasses.

6. Cyanamid

The granular form and a dusting grade of this compound are effective on small annual weeds and grasses in asparagus. 400# per acre, divided into two or three applications, will give satisfactory control of weeds.

7. Stoddard Solvent

Stoddard Solvent, when used on certain members of the parsley family, has been the most successful selective chemical yet found in vegetable crops for the control of annual weeds. 50-60 gallons per acre, directly over the row, or 100 gallons for over-all spraying is suggested for carrots, parsnips, parsley, caraway and dill. Stoddard Solvent shows promise for the control of annual weeds when applied just prior to the emergence of slow germinating crop plants. Kerosene and gasoline are not recommended for use as selective sprays in vegetable crops.

8. Other petroleum products

Several petroleum products have proven to be effective as general contact herbicides. Recent work indicates that some of these materials may be useful before crop emergence but no general recommendations can be made.

9. Sulfuric Acid

A 2% solution (by volume) of sulfuric acid, at a rate of 100-150 gallons per acre, is recommended for control of small broad-leaved weeds, except lamb's quarters, in onions. Pumps that are acid-resistant are required for use with sulfuric acid.

B. Recommendations for the use of 2,4-D on specific weeds

1. Weeds in lawns and turf. 2,4-D continues to be the outstanding chemical for the control of broad-leaved weeds in lawns other than bent grass. September treatments, which permit the grass to fill in the bare places for a considerable period before weed seedlings start, are being increasingly used instead of spring treatments.

2. Field bindweed. 2,4-D may be recommended as an excellent tool for the control, and to assist in the eradication, of field bindweed. The use of 2,4-D is recommended where bindweed is growing in perennial grasses, in small grains, in corn, and as a substitute for or in combination with cultivation.

3. Canada thistle and perennial sow thistle. Canada thistle and perennial sow thistle have not been killed by one treatment of the tops with any concentration of 2,4-D. The tops can be killed in pastures and other grasslands, in small grains, in corn, and as a substitute for or in combination with cultivation. Repeated treatments for two, three, or more years may be necessary to eradicate these thistles.

4. Hoary cress. 2,4-D can be advantageously used in grass sods and in connection with tillage and the growth of crops to prevent seeding, reduce the spread by underground parts, and aid in ultimate eradication of hoary cress. It can be recommended as the best method of treatment of this weed in perennial grass sods. Hoary cress is moderately tolerant to 2,4-D, particularly after it comes into bloom, hence the esters of 2,4-D should be used and the applications made in spring and/or fall. For fall treatments it is desirable to plow the land in midsummer to eliminate annual weeds and provide for complete emergence and the development of the rosette stage prior to fall treatment.

5. Leafy spurge. 2,4-D cannot be recommended at present for the eradication of leafy spurge. While the top growth is readily destroyed the roots are not seriously affected by one application. Repeat applications made at the time the plant is in bud or early flower result in marked weakening or "thinning out" of stands.

C. Comparisons of metallic salts, amine salts, and esters of 2,4-D

On the basis of equivalent weights of the acid, the following comparisons between metallic salts, amine salts, and esters of 2,4-D are valid:

(1) When the dosage approaches the maximum tolerance or when the time of application is before or after the optimum stage of growth, crop plants are injured most easily by the esters and least readily by the metallic salts. The amine salts are in an intermediate position. Varieties of the same crop may vary markedly in their resistance to 2,4-D.

(2) Weed plants, especially the species which are more tolerant to 2,4-D, and any species treated before or after the optimum stage of growth, may be most easily killed by the esters and least easily killed by the metallic salts. The amine salts occupy an intermediate position.

(3) The oily character of the esters makes them more effective under very dry conditions and when rain falls soon after application.

(4) There is generally less difference between these formulations when used as pre-emergence sprays than in post-emergence applications.

D. The use of pre-emergence sprays

Pre-emergence treatment is a promising control for annual weeds but is still in the testing stage. Results from different areas are conflicting, and until the factors involved are better understood, no general recommendations can be made.

E. The use of post-emergence sprays on weeds in crops

In all of the recommendations in this section, the esters should be used at lower rates than the salts.

1. Corn and sorghum. At the most susceptible stages of growth, from 1/4 to 1/2 pound acid per acre is the maximum safe dosage for most varieties of corn and sorghum. Where weed conditions require it, higher dosages may be used, but some reduction in yield may result.

2. Winter wheat. In winter wheat, selective treatments with 2,4-D are recommended for use in the spring to control annual and winter annual weeds. Such treatments usually give profitable results only when the weed infestation is heavy and the crop is unusually late or thin and unable to provide normal competition with weeds. Applications of 2,4-D at 1/4 to 1 pound acid per acre usually give satisfactory control of susceptible annual weeds and seldom cause serious injury to winter wheat, sprayed when fully tillered or after bloom. Heavier rates of 2,4-D treatment, necessary for the control of less susceptible perennial weeds, usually reduce yields but may be desirable to prevent weed seed production and facilitate harvesting. Fall applications of 2,4-D even at light rates frequently cause severe damage to winter wheat.

3. Spring wheat, oats, barley. Wheat is indicated to be the most tolerant to 2,4-D of the spring grains. At rates of application in excess of one-half pound acid per acre some damage, reflected in reduced yield, can be expected in the three grains. Only where the potential hazard of weeds requiring greater dosage for control outweighs the loss of crops resulting from the treatment, should 2,4-D in excess of three-fourths pound per acre be used on wheat, oats or barley.

(1) For control of weeds such as mustards, Frenchweed, marshelder, ragweeds, sunflower, cocklebur, hedge bindweed and similar susceptible species:
   a) One-fourth pound or less of 2,4-D acid per acre.
   b) Apply at full tiller stage.

(2) For control of weeds such as field bindweed, Canada thistle, sow thistle, wild lettuce and similar species:
   a) One-half to three-fourths pound 2,4-D acid per acre.
   b) Apply at late tiller to early shooting stage.

4. Flax. Flax has shown large varietal differences in response to 2,4-D both in relation to yield and percent and quality of oil. Of the eight varieties tested, Crystal and Minerva were very susceptible to injury in all respects. B 5128 was susceptible to yield injury. Redwing, Sheyenne, and Royal were most tolerant followed closely by Kota and Dakota. The ester formulations are more hazardous than either the amine salts or sodium salts and should be used only at a minimum dosage for weed control. In general, rates of application sufficient to eliminate the common broad-leaved annual weeds associated with flax, made when the weeds were fully emerged, have resulted in little or no reduction in flax seed yields.

(1) For control of mustard, Frenchweed, sunflower, cocklebur, ragweed, marshelder, and similar susceptible species in tolerant varieties:
   a) Apply not to exceed 1/8 to 1/4 pound of 2,4-D acid per acre.
   b) Make applications when flax is two to six inches high and weeds are in the four leaf, or rosette stage.

Where flax is infested with weeds requiring in excess of 1/4 pound 2,4-D acid per acre for control, and where these weeds are a substantial potential hazard, application of 2,4-D in excess of one-fourth pound per acre with probable reduction in flax seed yield may be justified. For such situations the following recommendation is offered:

(1) For control of bindweed, Canada thistle, sow thistle, smartweed, wild lettuce, artichoke and other similar species:
   a) Use 1/4 to 3/4 pound 2,4-D acid per acre as required to control the weed species involved.
   b) Apply when flax is six inches to first bud or when weeds are in rapid growth but pre-bloom stage.

5. Grass crops. Young seedling grasses are in general sensitive to 2,4-D. When the root systems are well established and a sod formed, most species of perennial grasses show a high degree of tolerance to 2,4-D at rates of application used in weed control. Creeping bentgrass is somewhat sensitive to 2,4-D. The following recommendations are suggested for most perennial grasses:

(1) Use only enough 2,4-D to control the weeds infesting the grasses; 1/4 to 1/2 pound 2,4-D acid per acre for susceptible annuals and biennials; 1/2 to 1-1/2 pounds 2,4-D acid per acre for more resistant species.
(2) Apply 2,4-D to grasses used as seed crop at the time when weeds are in active growth and before appearance of seed heads of grasses.

F. Eradication of woody plants

1. Where machines are available for clearing brush and trees on range pastures, they are recommended for use in eliminating woody plants.

2. 2,4-D as foliage spray should be applied only to those plants that are "Susceptible" or "Intermediate" as indicated in the table contained in the report of the subcommittee on woody plants to the Conference.

3. Ammonium sulfamate (as a dry salt) and 2,4-D (as concentrated esters) when applied to freshly cut surfaces at ground level are eradication tools for which the most efficient use has not been determined. There is evidence that when either of these chemicals is applied to freshly cut surfaces, they will prevent sprouting in a worthwhile percentage of cases.

G. Methods of application

1. In large scale spraying the concentrated sprays are replacing the con-

ventional dilute sprays. Weed control, crop injury and drift are considered to be about equal for either method, but the concentrated sprays can be applied more cheaply and with greater ease. The dilute sprays penetrate dense foliage better than concentrated sprays.

2. The scarcity of water, inaccessibility of certain terrains and the availability of dusting machinery are reasons for using 2,4-D dusts. Likelihood of drift is recognized as a drawback.

3. Application of 2,4-D sprays from airplanes gives performance substantially equal to ground-machine application as far as weed control and crop injury are concerned. The application of 2,4-D by airplane is discouraged in areas where drift on to susceptible crops is possible. All planes used for spray applications should be equipped with positive shut-off valves at the nozzles.

H. Toxicity of 2,4-D to livestock

Extensive trials of feeding 2,4-D directly to livestock and of permitting livestock to graze on treated vegetation have demonstrated clearly that no ill effects to livestock are to be anticipated from any of the present commercial forms of 2,4-D, even at rates considerably higher than those recommended for weedkilling.

I. Recommendations for labeling herbicides

Labels should contain the following information:

(1) For solids, the net weight (avoir.) in the package.

(2) For liquids, the content of the package in liquid measure.

(3) Name and percentage by weight of the actual active ingredient, such as sodium chlorate, borax, sodium arsenite (if labeled for herbicide use), ammonium dinitro-sec-butylphenate, sodium 2,4-dichlorophenoxy acetate and methyl 2,4-dichlorophenoxy acetate. This statement is acceptable everywhere and is required in several states. The Federal law permits an alternate statement of all ingredients whether inert or active plus a statement of total percentage of inert ingredients.

(4) It is further recommended that with materials of the 2,4-D type the following additional information should be given:
   a) For solid compositions, a statement of percentage by weight of the equivalent 2,4-D acid, and
   b) For liquid compositions a statement of percentage by weight of equivalent 2,4-D acid and weight of equivalent 2,4-D acid in a unit of volume.

J. Flame cultivation

The flame cultivator is worthy of further trials. The implement requires careful adjustment and a certain skill on the part of the operator, which comes only with experience.

In previous years the Committee has published a list of weeds of which are susceptible, intermediate, and resistant in their reaction to 2,4-D. This year a first attempt was made to put this on a better basis by indicating the amount of 2,4-D per acre required to kill each weed at various stages of growth. Each member of the Research Committee was asked to submit data. Fourteen reports were submitted. Those on annual weeds were summarized by Oliver C. Lee and those on perennial weeds by Kenneth O. Buchholtz. A similar list of woody plants is given by L. W. Melander in the report of that sub-committee. There was considerable variation in the reports of different members of the committee. However, there was no opportunity at Topeka for discussion of these reports by the entire committee and they are submitted as prepared. The Research Committee will be glad to have additional data supporting, modifying, or contradicting these preliminary reports, and similar reports on additional weeds.

In order to bring all material together, the 1946 classification as susceptible, intermediate, and resistant has been added to the tables. The many inconsistencies in the tables glaringly indicate the need for further work. Clearly, these tables must not be taken as more than suggestive approximations.

Many investigators reported that less 2,4-D was required in the form of an ester than for salts of 2,4-D. This has also been emphasized in the recommendations of the Policy Committee, but sufficient data are not available to prepare separate recommendations for the different materials.

Effect of 2,4-D on Annual Weeds

Weed	Classification 1946	Pounds 2,4-D per acre required to kill at stage*					Required to prevent seed production at stage**		
		1	2	3	4	5	1	2	3
Annual bluegrass Poa annua	R								
Barnyard grass Echinochloa crus-galli	R	3.0	R	R	R	R			
Bedstraw Galium sp.	I	.25	0.5	0.5	0.5	0.5			
Beggar-ticks Oappula echinata	S	0.5	0.5	0.5	1.0	1.0			
Bitter wintercress Barbarea barbarea	S	0.5	0.5	1.0	1.0	1.0			
Black medic or yellow trefoil - Medicago lupulina	S	.25	.25	0.5	0.5	0.5			
Black nightshade Solanum nigrum	R	2.0	2.0	R	R	R			
Blue bur Lappula sp.	S	1.0	1.0	1.0	2.0	2.0			
Buckwheat, wild Polygonum convolvulus	I	0.5	1.0	1.0	1.0	1.0	.25	.25	.25
Buffalo bur Solanum rostratum	R	1.0	R	R	R	R			
Butterprint, Indian mallow or velvetleaf - Abutilon theophrasti	S	0.5	0.5	1.0	1.0	1.0			
Carpetweed Mollugo verticillata	S	0.5	0.5	1.0	1.0				
Catchflys Silene sp.	R	R							
Chess or cheat Bromus secalinus	R	R	R	R	R	R			
Chickweed, common Alsine media	I	1.0	1.0	1.0	1.0	1.0			
Cocklebur Xanthium sp.	S	0.5	1.0	1.0	1.0	1.5	.25	.25	0.5
Coreopsis Coreopsis tinctoria	I								
Corn cokle Agrostemma githago	R	R	R	R	R	R			
Cow cockle Saponaria vaccaria	R								
Crabgrasses Syntherisma sp.	R	1.0	1.5	R	R	R			
Dodders Cuscuta sp.	I	.25	.25	0.5	0.5	0.5			
Downy brome Bromus tectorum	R	R	R	R	R	R			
False flax Camelina sp.	S	0.5	0.5	1.0	1.0	1.0			

Weed	Classification 1946	Pounds 2,4-D per acre required to kill at stage*					Required to prevent seed production at stage		
		1	2	3	4	5	1	2	3
Fanweed, Frenchweed, Stinkweed - Thlaspi arvensis	S	0.5	0.5	1.0	1.0	1.0			
Fleabane, Canada Leptilon canadensis	I	1.0	1.0	3.0	R	R	1.0	1.0	3.0
Fleabane, daisy Erigeron annus	I	0.5	0.5	1.0	1.0	1.0			
Fleabane, Philadelphia Erigeron philadelphicus	I	0.5	0.5	1.0	1.0	1.0			
Flower-of-an-hour Hibiscus trionum	S	0.5	0.5	0.5	0.5	0.5			
Foxtails, green and yellow - Chaetochloa sp.	R	R	R	R	R	R			
Galinsoga Galinsoga parviflora	S								
Goose grass Eleusine indica	R	1.0	R	R	R	R			
Goosefoot, oak-leaved and others - Ceenopodium sp.	I	0.5	0.5	1.0	1.0	1.0			
Hemp, marihuana Cannabis sativa	S	0.5	0.5	1.0	2.0	2.0			
Hemp nettle Galeopsis tetrahit	S								
Henbit or dead-nettle Lamium amplexicaule	S	1.5	R	R	R	R			
Indian mallow (See Butterprint)									
Jewelweed Impatiens pallida	S								
Jimsonweed Datura stramonium	S	1.0	1.0	1.5					
Knotweed, doorweed Polygonum aviculare and P. erectum	I	1.0	1.5	1.5	1.5	1.5	0.5	0.5	1.0
Kochia Kochia scoparia	S	0.25	0.25	0.5	1.0	1.5	0.25	0.25	0.5
Lamb's quarters Chenopodium album	I	0.5	1.5	1.5	1.5	1.5	0.25	0.25	0.5
Lettuce, prickly Lactuca scariola	I	0.25	0.25	0.5	1.0	1.0	0.25	0.25	0.25
Lettuce, wild Lactuca sp.	I	1.0	1.0	1.5	2.0	R	1.0	1.0	1.5
Mallow, roundleaved Malva rotundifolia	I	0.5	0.5	1.0	1.0	1.0	0.25	0.5	1.0
Marsh elder Iva xanthifolia	S	0.25	0.25	0.5	1.0	1.5	0.25	0.25	0.5
Mat spurge Euphorbia glyptosperma	I	R	R	R	R	R			
Mayweed or dog-fennel Anthemis cotula	I								

Weed	Classification 1946	Pounds 2,4-D per acre required to kill at stage*					Required to prevent seed production at stage		
		1	2	3	4	5	1	2	3
Morning glory (annuals only) Ipomea sp.	S	0.5	0.5	1.0	1.0	1.0			
Mustard, ball Neslia paniculata	S	0.25	0.25	0.5	0.5	0.5	0.25	0.25	0.25
Mustard, hare's ear Conringia orientalis	S	0.25	0.25	0.5	0.5	0.5	0.25	0.25	0.25
Mustard, Indian Brassica juncea	S	0.25	0.25	0.5	0.5	0.5	0.25	0.25	0.25
Mustard, tumbling Sisymbrium altissimum	S	0.25	0.25	0.5	0.5	0.5	0.25	0.25	0.25
Mustard, wild or charlock - Brassica arvensis	S	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Mustard, wormseed or treacle - Erysimum cheiranthoides	S	1.0	1.5	1.5	2.0	R	0.5	0.5	1.0
Mustard, tansy Sophia sp.	S	0.5	1.0	1.5	2.0	R	0.5	1.0	1.5
Orache Atriplex hastata	S	0.25	0.5	0.5	0.75	0.75			
Peppergrasses Lepidium virginicum and apetalum	S	0.5	0.5	1.0	1.0	1.0			
Pigweed, rough Amaranthus retroflexus	S	1.0	1.0	2.0	R	R	1.0	1.0	2.0
Pigweed, prostrate Amaranthus blitoides	S	0.5	1.0	1.0	1.0	1.0	0.25	0.25	0.25
Pineapple weed, wild Matricaria matricarioides	S	0.5	0.5	0.5	0.5	0.5	0.25	0.25	0.25
Prostrate vervain Verbena bracteata	S	0.25	0.25	0.5	0.5	0.5	0.25	0.25	0.25
Puncture vine Tribulus terrestris	S	0.5	0.5	1.0	2.0	3.0	0.25	0.25	0.25
Purslane Portulaca oleracea	I	1.0	2.0	3.0	R	R			
Radish, wild Raphanus sativus	S								
Ragweed, common Ambrosia elatior	S	0.5	1.0	1.0	1.0	1.0	0.25	0.25	0.25
Ragweed, giant Ambrosia trifida	S	0.5	0.5	0.75	1.0	1.0	0.25	0.25	0.25
Rough cinquefoil Potentilla monspeliensis	S		2.0	2.0	3.0				
Russian thistle Salsola pestifer	I	1.0	1.0	R	R	R	1.0	2.0	R
Saltbushes Atriplex sp.	S	0.25	0.25	1.0	1.0	2.0	0.25	0.5	1.0
Sandburs Cenchrus sp.	R	R	R	R	R	R	R		
Shepherds purse Bursa bursa-pastoris	I	0.25	0.5	0.5	1.0	1.0	0.25	0.25	0.25

Seed	Classification 1946	Pounds 2,4-D per acre required to kill at stage*					Required to prevent seed production at stage		
		1	2	3	4	5	1	2	3
Smartweeds Persicaria sp.	I	0.5	1.0	1.0	1.0	1.5	0.5	0.5	0.5
Sow thistle, annual Sonchus oleraceus	S								
Speedwells Veronica sp.	I	1.5	1.5		1.5	1.5			
Squirrel-tail grass Hordeum jubatum	R	R	R	R	R				
Sunflower Helianthus annuus	S	1.0	1.0	1.0	1.0	1.5	1.0	1.0	1.0
Tumbling amaranth Amaranthus graecizans		1.0	1.0	2.0	R	R	1.0	1.0	2.0
Vetches Vicia sp.	S	0.75	1.0	2.0	2.0	2.0			
Wild cucumber Sicyos angulatus	S								
Wood sorrel Oxalis sp.	R	1.5	R	R	R	R			
Yellow star thistle Centaurea solstitialis	S								

*Stage 1. Seedlings with not more than 4 true leaves.
Stage 2. Seedlings in rapid growth, pre-bud.
Stage 3. Bud stage.
Stage 4. Full bloom
Stage 5. Early seed stage.

Use "R" if not killed by 4 pounds per acre.

Effect of 2,4-D on Perennial and Biennial Weeds

Weed	Classification, 1946	2,4-D per acre required to kill tops: Young Growth	Rapid Growth	Bloom	Applications required to kill roots at most susceptible stage
		Lb.	Lb.	Lb.	No.
Alkali mallow Sida hederacea	R	R	R	R	-
Artichoke, Jerusalem - Helianthus tuberosus	S	1	2	2	1
Aster, Aster multiflorus	-	2	2	2	1 plus
Aster, fall - Aster sp.	R	-	-	3	1 plus
Austrian cress Roripa sustriaca	S	1	1	1	1 plus
Bermuda grass Cynodon dactylon	R	R	R	R	-
Bindweed, field, west of the Mississippi River - Convolvulus arvensis	S	1	1	2	2 plus
Bindweed, field, east of the Mississippi River - Convolvulus arvensis	S	1	1	1	1 plus
Bindweed, hedge Convolvulus sepium	S	1	1	2	1
Bittersweet, climbing nightshade - Solanum dulcamara	R	R	R	R	-
Bladder campion Silene latifolia		2	2	2	2 plus
Blueweed Helianthus ciliaris	I	2	2	2	1 plus
Bouncing bet Saponaria officinalis	I	R	R	R	-
Buckhorn Plantago lanceolata	S	1	1	1	1
Bull thistle Circium lanceolatum	S	1	1	1	1
Burdock - Arctium minus	S	1	1	2	1
Bur ragweed Franseria tomentosa	I	2	2	2	1 plus
Buttercups - Ranunculus sp.	I	1	1	2	1
Cactus, prickly pear Opuntia sp.	R	R	R	R	-
Canada thistle Cirsium arvense	I	1	2	2	3 plus
Carrot, wild Daucus carota	I	1	1	2	1

Effect of 2,4-D on Perennial and Biennial Weeds, Cont'd

Weed	Classification, 1946	2,4-D per acre required to kill tops: Young Growth	Rapid Growth	Bloom	Applications required to kill roots at most susceptible stage
		Lb.	Lb.	Lb.	No.
Cattails - Typha sp.	I	R	R	R	-
Catnip - Nepeta cataria	S	1	1	1	1
Chicory - Cichorium intybus	S	1	2	2	1
Cinquefoils, fivefingers Potentilla sp.	S	0.5	0.5	1	1
Climbing milkweed Gonolobus laevis	R	R	R	R	-
Compass plant - Silphium sp.		-	-	3	-
Coneflowers - Ratibida sp.	S-	0.5	0.5	1	1
Creeping Charley (See ground ivy)					
Creeping Jenny (See bindweed, field)					
Dandelion Taraxacum officinale	S	1	1	1	1
Dock, curled - Rumex crispus	I	1	1	2	1
Dock, broad-leaved Rumex obtusifolius		1	2	2	1
Dock, smooth Rumex altissimus		1	2	R	1 plus
Dogbane Apocynum cannabinum	I	1	2	R	1
Dragonhead Dracocephalum parviflorum	S	0.5	1	1	1
Evening primroses Oenothera sp.	S	1	1	1	1
False sunflower Heliopsis scabra	S	1	1	1	1
Ferns Asplenium sp., Aspidium sp.	R	R	R	R	-
Figwort Scrophularia leporella	S	1	1	2	1
Five finger (See cinquefoils)					
Four-o'clock, wild Allionia nyctagenia	S	1	2	2	1
Foxglove beardtongue Penstemon digitalis	R	R	R	R	-
Goatsbeard - Tragopogon sp.	I	1	1	2	1
Goldenrods - Solidago sp.	I	1	2	R	1 plus
Gourd, wild Cucurbita foetidissima	I	R	R	R	-

Effect of 2,4-D on Perennial and Biennial Weeds, Cont'd

Weed	Classification, 1946	2,4-D per acre required to kill tops			Applications required to kill roots at most susceptible stage
		Young Growth	Rapid Growth	Bloom	
		Lb.	Lb.	Lb.	No.
Goutweed Aegopodium podagraria	R	R	R	R	-
Ground cherry - Physalis sp.	R	R	R	R	-
Ground ivy - Glecoma hederacea	S	1	2	2	1
Gumweed - Grindelia squarrosa	S	0.5	0.5	1	1
Heal-all - Prunella vulgaris	S	0.5	1	1	1
Hedge bindweed (See bindweed)					
Hedge nettle Stachys palustris	S	1	1	2	1
Hoary alyssum Berteroa incana	S	1	1	2	1
Hoary cress - Lepidium draba		2	2	R	2 plus
Hoary vervain Verbena stricta	R	1	1	2	1
Hop - Humulus lupulus		2	2	2	1
Horse nettle Solanum carolinense	R	R	R	R	-
Horsetail Equisetum arvense	S	1	1	1	2
Houndstongue Cynoglossum officinale	I	1	1	1	1
Ironweed Vernonia altissima		R	R	R	R
Johnsongrass Sorghum halepense	R	R	R	R	-
Lawn pennywort Hydrocotyle umbellata	S	1	1	1	1
Lettuce, blue perennial Lactuca pulchella	I	1	1	2	1 plus
Licorice, wild Glycorrhiza lepidota	S	1	1	1	1
Loco weed Oxytropsis lamberti	S	1	1	1	1
Milkweed, common Asclepias syriaca	R	R	R	R	-
Milkweed, whorled Asclepias verticillata		1	2	2	2 plus
Moonseed Menispermum canadense	S	2	2	R	1
Motherwort Leonurus cardiaca		2	2	2	1

Effect of 2,4-D on Perennial and Biennial Weeds, Cont'd

Weed	Classification, 1946	2,4-D per acre required to kill tops: Young Growth	Rapid Growth	Bloom	Applications required to kill roots at most susceptible stage
		Lb.	Lb.	Lb.	No.
Mouse-ear chickweed Cerastium vulgatum	S	1	1	2	1
Mullein, common Verbascum thapsus	R	R	R	R	-
Nettle, stinging Urtica dioica	S	0.5	0.5	1	1
Night-blooming catchfly Silene noctiflora	R	R	R	R	-
Nimblewill Muhlenbergia schreberi	R	R	R	R	-
Ox-eye daisy Chrysanthemum leucanthemun	R	2	2	R	2
Per. peppergrass (See hoary cress)					
Per. sow thistle Sonchus arvensis		2	2	2	2 plus
Plantain, common Plantago major and rugelii		0.5	0.5	1	1
Pokeweed Phytolacca decandra	I	2	2	3	2
Poppy mallow Callirrhoe involucrata	S	1	1	1	1
Poverty weed - Iva axillaris	I	2	2	2	1 plus
Quackgrass - Agropyron repens	R	R	R	R	1
Roadside thistle Cirsium discolor	S	1	1	2	1
Rosin weed - Silphium sp.	S	1	1	3	1
Rush, club Scirpus atrovirens		R	R	R	-
Russian knapweed Centaurea repens	R	2	2	2	3 plus
Sagebrush or wormwood Artemisia sp.	S	1	2	R	1
Scouring rush (See horsetail)	S				
Silverleaf poverty weed Franseria discolor	I	1	2	2	1 plus
Skeleton weed Lygodesmia juncea	S	1	1	1	1
Slender rush - Juncus tenuis	S	R	R	R	-
Sorrel, red or sheep Rumex acetocella	I	2	2	R	2

Effect of 2,4-D on Perennial and Biennial Weeds, Cont'd

Weed	Classification, 1946	2,4-D per acre required to kill tops: Young Growth	Rapid Growth	Bloom	Applications required to kill roots at most susceptible stage
		Lb.	Lb.	Lb.	No.
Spurge, cypress Euphorbia cyparissias	R	R	R	R	-
Spurge, emarginated - snow-on the mountain Euphorbia marginata	R	R	R	R	-
Spurge, leafy Euphorbia esula	R	2	2	2	3 plus
Strawberry, wild Fragaria americana	R	R	R	R	-
Sunflowers (perennial) Helianthus sp.	S	1	1	1	1
Swamp or perennial smartweed tanweed - Persicaria coccinea	R	R	R	R	-
Sweetclovers - Melilotus sp.	S	0.5	1	2	1
Tansy ragwort Senecio jacobaea	R	R	R	R	-
Teasel - Dipsacus sylvestris	I	R	R	R	-
Tick-trefoils - Meibomia sp.	R	1	R	R	-
Toadflax - Linaria vulgare	R	R	R	R	-
Vervains - Verbena sp.	S	1	1	2	1
Vetch, bird or tufted Vicia cracca	S	1	1	1	1
Vetch, crown - Coronilla varia	S	1	1	1	1
Violets - Viola sp.	R	R	R	R	-
Water hemlock Cicuta maculata	S	1	1	1	1
Western ragweed Ambrosia psilostachya	S	1	1	2	1
White cockle - Lychnis alba	R	R	R	R	-
Wild garlic - Allium vineale	I	3	3	3	3 plus
Wild onion - Allium canadense	I	3	3	3	2 plus
Wild onion - Allium nuttallii		R	R	R	-
Wild parsnip Pastinaca staiva	S	1	1	2	1
Wild sweet potato, man-of-the-earth Ipomea pandurata	S	2	2	2	1
Yarrow - Achillea millifolium	I	2	2	3	1 plus

SECTION II: WEED CONTROL IN HORTICULTURAL CROPS
December 10, 1947

The meeting was called to order by Chairman Dr. B. H. Grigsby of Michigan. Dr. Grigsby opened the discussion by talking on the use of Stoddard's Solvent and other petroleum products for use as herbicides in various vegetable crops.

Stoddard's Solvent has been extensively tested as a herbicide in weed control, both as a pre and post-emergence spray, in carrot, parsnip, and dill, and less extensive trials have been conducted with asparagus, onions, and celery. Dosages ranging from 50 to 100 gallons per acre have been used on carrot, parsnip, and dill without injury to the crop plants. However, the lower dosages were ineffective unless repeated. The herbicide has imparted an oily flavor to carrots if applied to plants too late in the season, after the roots had reached some size.

Dr. Grigsby's remarks were supplemented by discussion from the floor. Dr. E. K. Alban of Ohio reported on the use of oil sprays for pre-emergence weed control on some 26 vegetable crops. A spray of 100 gallons of Stoddard's Solvent killed all weeds above ground and the fields remained weed free for a period of two weeks following treatment. Dr. Grigsby also reported on the use of sodium chloride as a herbicide on onion grown in muck soil. A saturated solution applied at 100 gallons per acre gave adequate weed control without reduction in crop yields. Grigsby also reported that Stoddard's Solvent had given control of weeds in celery seed beds but that some injury (black heart) resulted when plants eight to ten inches tall were sprayed in the field after transplanting. Plants that had not been sprayed as seedlings were less susceptible to injury than were those sprayed in the seed bed.

The use of 2,4-D as a pre-emergence spray was discussed, but the general opinion of those taking part seemed to be that additional work would be needed before such use could be recommended.

The use of 2,4-D as a herbicide in asparagus was discussed at length, with those who had used the chemical on this crop apparently in agreement that, while no immediate serious injury was apparent, more study of the long-range aspects of the problem was needed before recommendations could be made. To quote Dr. Alban of Ohio, "I wish I could see those treated (asparagus) beds five years from now, and I would know what to tell the growers".

The Chairman called upon Dr. L. A. Bakke of Iowa to lead the discussion on weed control in potatoes and sugar beets. After a few opening remarks on his work with sodium chloride as a herbicide in sugar beets, Dr. Bakke introduced Mr. Harvey H. P. Johnson of the Beet Sugar Foundation for a report on work being carried on by the Foundation in the western part of the sugar beet area.

WEED CONTROL IN SUGAR BEETS
By: Harvey P. H. Johnson *

Weed control has been rated as the number one problem in the spring mechanization of the sugar beet industry. Commercial machines are now available which

*Statistician-Agronomist, The Beet Sugar Development Foundation

will do a satisfactory job of spring thinning providing a careful precision planting is made with processed seed. Thinning is only one phase of the spring work and unless the weed growth in beets can be controlled, the maximum labor displacement is not effected.

The industry is searching for a solution to the weed problem. Two main approaches have been taken: (1) Chemical weed control and (2) mechanical weed control. To date greater advances have been made on the mechanical approach. A combination of these two controls can be used although in some areas, notably California, the theory behind chemical weed control calls for a minimum of mechanical disturbance of the soil. This report will deal largely with approach No. 1 (chemical weed control) with brief discussions of some of the mechanical tools found useful.

The Beet Sugar Development Foundation, a sugar processor sponsored organization, has as one of its main objectives, the solution of the weed problem. Operating as it does through grants with colleges, sugar companies and other interested persons the technical phases of the experimental work is frequently not carried on by the Foundation but rather with these cooperating agencies. This is the case with chemical weed control. The progress report given in this paper covers some of the work conducted in 1947 by:

1. Dr. W. W. Robbins, Botanist, University of California
2. Dr. Russell T. Nelson, Agronomist, Great Western Sugar Company
3. Mr. P. A. Reeve, Agricultural Supervisor, Farmers and Manufacturers Beet Sugar Association,
4. Mr. L. G. Smith, Technical Products Department, Shell Oil Company
5. Mr. W. A. Westgate, West Coast Representative, Standard Agricultural Chemicals, Inc.

Dr. Robbins has tested the toxic effect on sugar beets of various chemicals. In the range of less cost materials, he recommended for further experimental study in 1947, the use of diesel oils, either alone, mixed with water or with fortifying agents added.

The value of herbicides of such petroleum fractions as diesel oil and stove oil has been known for some time. One of the major problems involved in the use of fuel oils for weed killing purposes has been its increased cost and its decreased effectiveness as a weed killer. It seems that as the petroleum industries improve the fuel quality of an oil, they at the same time decrease its herbicidal qualities. As the gravity goes up the toxicity goes down. Dr. Robbins reports the greater effectiveness from diesel oil with 31.3 gravity. Higher gravity oils have been used by Dr. Nelson at Longmont with success although he also found the lighter oil more effective. Inasmuch as commercial fuel oils are tending towards higher refinement, interest has grown in fortifying oils in hopes that not only a better weed killer can be formed but a cheaper one also. The sulphur content of oil has long been known to be one of the desirable constituents for weed killing purposes. This has led to the practice of adding elemental sulphur to the oil to increase its effectiveness. Pentachlorophenol and dinitro-cresol also were one of the earlier chemicals employed for this same purpose and are still being used. Twenty-five hundredths of one percent pentachlorophenol with an emulsifier added has been found to be the cheapest and most effective fortifying agent with diesel oils in California excelling the dinitro compounds for sugar beet pre-emergence sprays. Experimental work by various chemical and oil companies

may shortly produce a product which is superior to the fortifying agents now used with diesel oil.

Rates of application for both experimental and commercial use have approximated 50 gallons of diesel fuel per acre. Attempts to reduce the amount of oil used per acre have been made either by making the spray a mixture with varying amounts of water, reducing the portion of the row covered or the addition of a fortifying agent. General conclusions indicate that the rate of kill has been more rapid in the case of those sprays which were fortified with either dow General, sulphur, or pentachlorophenol and that the rate of kill increased with an increase in the amount of oil the mixture contained.

The best type of spray for weed control is a penetrating, low-pressure spray (40 to 150 lbs. pressure, depending upon size of nozzle orifice) with the least tendency to fog or drift. Dr. Robbins recommends a pressure of 75 lbs. The most efficient coverage is obtained from nozzles that discharge a fan-shaped pattern. Nozzles should be placed close to the weeds so as to avoid drift and nozzles settings should be such as to allow for 100% overlap.

One test conducted by Dr. Robbins in California had the following treatments:

Treatment	Rate per acre in gallons	Seeding Date - March 22 Herbicide applied about 6 days before emergence. % germination stand
1. Diesel oil (straight)	30	65.1
2. Diesel oil and Dow General* (1 qt. to 30 gals. of oil)	30	53.4
3. Diesel (1 part), water (4 parts), and emulsifier	50	47.4
4. Diesel oil (1 part), water (4 parts), Dow General (1 qt. to 30 gals. of Mixture) and emulsifier	50	56.4
5. Diesel oil (1 part), water (9 parts), Dow General (1 qt. to 30 gals. of mixture), and emulsifier	50	52.8
6. Diesel oil (1 part), water (1 part), Dow General (1 qt. to 30 gals. of oil) and emulsifier	50	75.2
7. Diesel oil (1 part), water (1 part), 4 lbs. sulfur to 30 gals. of oil, and emulsifier	30	63.5
8. Diesel oil (1 part), water (4 parts) pentachlorophenol (4 lbs. to 100 gals. of oil) and emulsifier	50	54.1

Treatment	Rate per acre in gallons	Seeding Date - March 22 Herbicide applied about 6 days before emergence. % germination stand
9. No treatment		72.4

* Active ingredient, dinitro secondary butyl phenol. (Active ingredient of Sinox General, dinitro secondary amyl phenol).

These treatments were applied on 3 seeding depths: 1 inch, 1½ inch and 2 inch. The percent germination stand given above is an average of the three for each treatment. The percent germination stand was approximately the same for all three depths of planting with the 2 inch planting showing a slight tendency towards a greater number of singles. The above stands give some indication on the effect of the spray on the emerging beet. It should be kept in mind, however, that the commercial beet grower considers 40% germination stand as very good.

Some general conclusions Dr. Robbins has made from this past season's work are:

1. All applications gave a satisfactory weed kill.

2. Little injury to emerging beet seedlings resulted from any of the applications when they were applied about 6 days before their emergence; injury to beet seedlings occurred, however, when the materials fortified with Dow General and pentachlorophenol were applied one or two days prior to emergence.

3. The sugar beet seedlings in sprayed plots developed in relatively weed-free soil, and without the competition which young weeds cause. These beet seedlings soon surpassed those which emerged in unsprayed plots in which beet seedlings entered into competition with weed seedlings.

4. Cultivation of sprayed plots was not necessary until well after thinnings.

5. The cost of blocking and thinning sprayed plots was much less than that of unsprayed plots.

Dr. Robbins also points out the advantages of pre-emergence spraying based upon his preliminary field tests:

1. It permits the preparation of seed beds in the fall, their subsequent settling during the winter, and seeding without any preliminary treatment, that is, reworking of the beds.

2. It eliminates competition of weeds in early stages of seedling growth, resulting in more vigorous plants and a better stand.

3. It reduces the number of cultivations, a practice which brings additional weed seeds to the surface, where they can germinate.

4. In the case of carrots, it prevents certain rapid-growing weeds from

reaching an advanced stage where they are difficult to kill with selective oil herbicides.

Commercial adaptation of diesel oils for pre-emergence sprays appears more likely in California where the winter season is mild. Weed growth in most of the beet growing areas there continues throughout the winter season, hence seed bed preparation can be made well in advance of beet planting allowing the weeds a head start. In the Rocky Mountain and the Eastern beet growing territories, the winter season is more severe and weed growth is retarded. Here the spring beet planting season comes at the same time as weed growth starts. A delay in planting is not desirable as experimental data shows that the earlier spring plantings net larger yields. In many areas, however, the crop rotation places a grain crop before beets. Volunteer grain comes early in the spring as does wild oats - here pre-emergence spraying may be of value. Another possible use of pre-emergence spraying in these areas is in the event of killing frosts injuring beet stands to the extent where replanting is necessary. Time can be saved by replanting the fields immediately rather than making land preparation again, then following the planting by a pre-emergence spraying which will kill the weeds and voluntary grain that withstood the frost.

Dr. Nelson, at Longmont, had some interesting results from spraying a beet field previously seeded to barley to simulate conditions of volunteer grain. The treatments used were:

1. 50 gallons diesel oil per acre sprayed over area (on and between rows).

2. 25 gallons diesel oil per acre applied to a 10" strip over the row (on row and 5" to either side of row). The purpose here being to economize on the amount required by reducing surface coverage then cultivating weeds between rows.

3. 30 gallons diesel oil per acre sprayed over entire area.

4. A knife attached to cultivator immediately ahead of planting to cut out barley growth.

5. No treatment.

All four treatments were far superior to the no treatment where the barley grew up and choked the beet growth. Treatment No. 2 showed good control in the narrow band that was sprayed. The mechanical treatment with the knife was as effective as any of the sprays, which could be expected since in this case the planting of beets was delayed until all the barley was up.

All chemical weed control discussed has been confined to pre-emergence spraying. Saturated salt solutions have been used to kill weeds after the beet plant is up. Mr. Reeve has been doing most of the work in this field and will report on results obtained. Carbamates have been used also but no information of any value is available as yet.

The diesel oils with and without fortifying agents have been found to be effective on most of the weeds that grow in beet fields. Some of the more common on which control has been found are: Mustard, wild radish, smartweed, annual chickweed, pigweed, lamb's quarter, watergrass, knotweed and wild oats.

New mechanical methods are coming into commercial use. Most outstanding is the finger weeder, sometimes referred to as the pencil weeder or bean weeder. The tool is not new but its use on beet fields has come about recently. The weeder has to be used several times, timing it with the early development of weeds. Its action is severe enough to kill weeds in early development yet not so severe as to injure the beet plant when it has developed beyond the four leaf stage. The weeder can be used any direction on the field but its most effective way is diagonally across the field alternating directions with subsequent cultivations. This practice was used commercially in 1947 on more than 5000 acres. Other tools that will do much the same job but perhaps not quite as effectively are the harrow, side delivery rake and ordinary dump rake.

Timeliness cannot be overstressed in the use of these mechanical tools. Once the weed has set root, it like the beet will not be removed by the finger weeder. It has been apply put that the beet grower must be more weed conscious and less beet conscious if the fullest use of these tools are to be realized.

Placing a ridge over the planted row is also a practice followed in weed elimination. The ridge can easily be made by placing a tool bar on the planter and fastening discs on it. The ridges will be from 4 to 6 inches high. If moisture is present the weeds will start their growth. The ridges are later removed when the beet seed has germinated. This disturbance to the top layer will give the emerging beet seedlings a head start on weeds. A necessary precaution in this practice is to watch the germination of the beet seed carefully. If too great a cotyledon growth has started, the harrowing for removal of ridges will injure emergence. This ridging method is also used for conserving limited spring moisture at planting time.

It is evident from this report that considerable work is yet necessary in developing methods for the control of weeds in sugar beets. We are indeed thankful that the question is being considered in this meeting and that an analysis of the problem will be made with consideration for suggestions on new approaches.

After a discussion from the floor, Dr. Bakke called on Mr. Grant E. Nichol, of the Farmers and Manufacturers Sugar Beet Association, Saginaw, Michigan, for a discussion of weed control work in the Great Lakes sugar beet area.

SELECTIVE WEED CONTROL IN SUGAR BEETS

By: Grant E. Nichol - Farmers and Manufacturers Sugar Beet Association, Saginaw, Michigan

The practice of using common salt (NaCl) in water as a selective weed killer on beets was begun by Dr. G. F. Warren of the University of Wisconsin. The possibilities offered by this method of weed control have created a great deal of interest in the sugar beet industry.

Preliminary work which we did in the summer of 1946 gave very encouraging results. Here a saturated salt solution was applied with a hand sprayer. This gave good control of ragweed, smartweed, wild mustard, and rough pigweed.

The principal annual weeds not affected were lambsquarters and purslane. Weed control was much more effective if spraying could be done when the weeds were small.

It was observed that some beets were killed by the spray. Subsequent investigation showed that this killing was principally limited to those which had not yet developed their first pair of true leaves.

A power sprayer was purchased in 1947 to conduct field experiments with salt sprays. This machine was equipped to spray four rows of beets. The spray was applied by four fan type weed nozzles, one being located directly over each row.

The salt solution was made up as the sprayer tank was being filled with water. Two pounds of finely ground NaCl per gallon of tank capacity was placed in the tank. By the time the tank was filled with water, all salt had gone into solution. A "spreader", or wetting agent, was added to the solution to increase its effectiveness.

The rate of application commonly used was 100 gallons of spray per acre. Results varied from one location to the other, depending on the kinds of weeds present and their size. In many cases, the weeds which were sprayed were not completely killed. However, their growth was stopped until the field could be cleaned up by hand labor. It should be borne in mind that most of this spraying work was done as a last resort before abandoning the field. An illustration of the practical application of this method of weed control is as follows:

W. D. Crowe of McGuffey, Ohio, had 36 acres of beets on muck soil which were heavily infested with smartweed. Due to wet weather, these beets could not be cultivated or thinned. The beet rows in this field were completely obscured by weeds. Spraying stopped the growth of smartweed until the field could be cultivated, blocked, and thinned. At harvest time this field yielded 11.17 tons of beets per acre.

A portion of one of our experimental fields this past year was to be devoted to a mechanical thinning test. Most of the field was hand blocked and thinned and was not sprayed. Those rows reserved for mechanical thinning were sprayed at the rate of 200 gallons of salt solution per acre in an effort to kill out a heavy infestation of ragweed and yellow foxtail. This heavy rate of application gave a complete kill on the ragweed, but burned the foxtail only slightly. The interesting factor is that the beets were apparently severely injured but later recovered and at harvest time actually out-yielded the unsprayed beets in adjacent rows.

A. W. Skuderna of the American Crystal Sugar Company reports that about 300 acres of beets were salvaged in one of their eastern areas in 1947 by the use of salt sprays. These beets were infested with smartweed.

Other reports have been coming in concerning farmers who have been using salt sprays to save beet fields that have become excessively weedy. Most of these farmers are growing beets on muck soils. Salt is commonly used as a fertilizer for beets on such soils.

SUMMARY

1. A concentrated sodium chloride solution has some value as a selective herbicide in sugar beets.

2. The effect on weeds is apparently due to Plasmolysis. The beets are resistant because of a waxy leaf covering.

3. This method of weed control is not widely practiced but may find a place where the principal weeds present are susceptible to this type of herbicide.

4. Indications are that NaCl sprays may have a beneficial effect on sugar beets, particularly those grown on muck soils.

The discussion on beets was followed by a general discussion on the use of 2,4-D in potatoes. Reports were conflicting, but it was agreed that:

1. Wide differences in varietial tolerance in potatoes exist.

2. There is need of more information on the effect of stage of growth, soil type and fertility, varietial tolerances, etc., on 2,4-D reactions.

3. That 2,4-D as a selective herbicide in potatoes shows some promise, but that much careful study of the problems involved will be necessary before recommendations can be made.

Dr. Oliver Leonard's report on the use of 2,4-D as a soil treatment for weed control in transplanted tomatoes and sweet potatoes gave evidence that the use of the herbicide was possible even in very susceptible crops previously considered as being in the "untouchable" class, and was an indication of the rapid progress that is being made in the field of chemical warfare on weeds.

Mr. O. C. Lee of Indiana read a paper by Bradley and Ellis on "The Effect of Different Formulations of 2,4-D and Other Weed Inhibitors Applied on Onions".

THE EFFECT OF DIFFERENT FORMULATIONS OF 2,4-D AND OTHER WEED INHIBITORS APPLIED ON ONIONS

R. H. Bradley and N. K. Ellis
Department of Horticulture, Purdue University

Plots of Early Yellow Globe onions were treated with various formulations of 2,4-D, Cyanamid (Aero Defoliant), Sodium Cyanamid, and Sulfuric acid at planting time, 7 days after planting but before emergence, and 10 days after planting which in this test, was a post emergence treatment. 2,4-D was applied at the rate of 3/4 pound 2,4-D acid per acre, cyanamid at 100 and 200 pounds per acre, sodium cyanamid at 50 and 100 pounds, sulfuric acid at 3 and 5 percent (by volume).

The results indicated that 2,4-D applied immediately after planting, was

not effective as a weed control measure and that applications just prior to emergence caused extensive damage to the onions.

Aero defoliant, in sufficient quantity to completely kill young weeds, was effective but smaller amounts tended to act as a stimulant to weed growth. Sodium cyanamid showed promise as a pre-emergence treatment, but caused serious injury to onions in the loop stage.

Sulfuric acid gave satisfactory weed control in all stages.

Dr. Grigsby then called on Glenn Viehmeyer of Nebraska to lead the discussion on weed control in fruit crops. Viehmeyer asked for discussion from the floor. An exchange of ideas on the possibilities of 2,4-D as a selective herbicide in strawberries took place with Willard of Ohio reporting that 1 pound per acre dosages of both the ester and salt forms of 2,4-D had caused no serious effects on plants or fruit of Catskill, Fairfax or Premier. Robert F. Carlson of Michigan reported that spraying blooming plants resulted in distorted foliage and fruit and that Robinson is more tolerant of 2,4-D than the variety Premier. Viehmeyer reported wide varietial differences in tolerance to 2,4-D among forty clones of hybrid strawberries.

Workers were agreed that weed control in strawberries seemed possible, but that more information on stage of growth, dosages and varietial tolerances were needed; and that recommendations would probably have to be made on a basis of varietial tolerances and local conditions.

Viehmeyer reported briefly on the use of 2,4-D for weed control in raspberries and stated that several varieties had been treated with the dosages necessary to control weeds with no apparent injury to the plants.

No worker had much to report on the use of 2,4-D in orchards. Viehmeyer reported that the herbicide had been used at North Platte, Nebraska, to control weeds in the row in young orchards with no apparent injury to the trees. It was the general opinion that a thorough investigation of the cumulative effects on fruit trees over a long period of time would be necessary before definite recommendations could be made.

A meeting to follow the banquet was called by Dr. Grigsby for the purpose of outlining a coordinated plan for weed research as related to horticultural crops on a regional basis. All interested persons were asked to attend.

The meeting was adjourned by Chairman Grigsby.

SECTION II: SYMPOSIA ON WOODY PLANTS
December 11, 1947

The meeting was called to order by Chairman Glenn Viehmeyer of Nebraska, who asked Mr. J. A. Abrahamson of Mount Arbor Nurseries, Shenandoah, Iowa, to lead the discussion on weed control in ornamental plants.

Mr. Abrahamson outlined the weed control problems of the commercial nurseryman and reported on a number of exploratory experiments he had conducted on the effect of soil treatments on the emergence of seedlings of a number of woody and herbaceous plants. Mr. Abrahamson's discussion was supplemented by remarks from the floor.

Chairman Viehmeyer called upon Dr. L. W. Melander to lead the discussion on the control of undesirable woody plants.

Mr. Chairman: It is not my desire to take up much time in the form of a talk because our opinions are expressed in the foreward of the subcommittee report. However, there are a few things which I would like to call to your attention.

As a matter of interest, this meeting perhaps can be called "epochal" from a historical standpoint. This is the first time that a symposium on controlling noxious woody plants in general ever has been held. I perhaps might be mistaken but none has come to my attention.

It is gratifying to note the increased interest in eradicating woody plants and it is our hope that more and more attention will be given research on this problem.

The subcommittee in its report emphasized that the inadequate amount of basic research now being carried on was seriously hampering progress of field experimentation. There is much needed data that only can be obtained through basic research. I have jotted down a few phases of woody plant control where more basic research data are necessary to search for vulnerable spots where plants can be attacked and killed.

1. How is a given herbicide absorbed by different woody plants?

   a. Physical chemistry studies of herbicides should give us more information on the improvement of sticking qualities of herbicides, absorption, etc., as well as to help perfect low volume, high atomization spray application techniques.

2. What basic factors govern entrance of herbicides into a given host?

   a. A search for new methods of getting herbicides to penetrate woody plants is essential because in many cases foliage sprays seem to be inadequate. Much information also is necessary to work out effective treatments for woody plants in the dormant stage. Year-round economical techniques for killing woody plants must be developed, and a tremendous amount of research is necessary to secure economical usable methods of eradication.

3. How does a given herbicide affect individual noxious plants as well as different parts of various noxious plants such as individual cells, leaves, stems, roots both top and lateral?

a. What factors affect killing processes of herbicides?

b. Why are some herbicides highly selective?

4. Means of obtaining compatibility between chemicals should be established so that different herbicides may be mixed and sprayed on composite groups of woody plants.

5. Studies of food storage in plants as related to the effect of herbicide on a given type of plant should be continued and completed for all noxious woody plants.

6. What factors produce seasonal variations in the effectiveness of herbicides?

These are just a few problems for basic research and there perhaps is much more basic information that could be obtained and used to good advantage.

The question arises as to what can be done to get more work done on basic research concerning the eradication of woody plants. Most research workers dealing with plant science have more problems to work with than they can handle efficiently. Therefore, I would like to offer a personal suggestion for your consideration. Since woody plant eradication is a special problem, it perhaps would be given more attention if the modern trend were followed of interesting all those agencies which spend millions of dollars each year eradicating noxious woody plants, to organize a "Woody Plant Control Institute". Similar organizations in other fields of endeavor are doing a real job of accomplishing their objectives. It has been my observation that they operate by helping existing research agencies so that more research can be done on a given important problem.

In conclusion, on behalf of the subcommittee, I wish to thank all of the investigators who made contributions to the report of this subcommittee.

Talk on chemical control of woody plants was given by Keith Barrons of Dow Chemical Company. An abstract of this paper is given by Barrons and Coulter in the report of the Research Committee later in these proceedings.

Mr. Barron's talk created a lively interest among representatives of public utilities and others to whom control of woody plants is a problem. A lively discussion of specific problems resulted and continued until Dr. Melander called upon Dr. E. J. Krause of the University of Chicago.

Dr. Krause spoke to the group on the broader aspects of the use of the growth regulating chemicals, as well as citing a number of interesting observations on specific problems, and complimented the conference on its progress in the following words: "I am particularly impressed by the work being done by this group. In the early days of 2,4-D flax was considered as being 'untouchable', and here I find you folks using it for the control of weeds in that crop!"

Following Dr. Krause's talk, the Section was adjourned by Chairman Viehmeyer.

End of Proceedings, Section II, Weeds in Horticultural Crops.

REPORT OF RESEARCH COMMITTEE

NORTH CENTRAL WEED CONTROL CONFERENCE, 1947

OFFICIAL ACTION OF THE COMMITTEE

The Research Committee sat in joint session with the Board of Directors in one meeting and held one business meeting at the Annual Conference in Topeka, December 10-12, 1947. A digest of the official action taken at that meeting is given below:

1. It was decided that a plan for needed weed research in the North Central Region be prepared and coordinated as closely as possible.

2. Each member of the Research Committee shall submit a list of research needed in his area to the chairman or other persons designated by the chairman so that sub-regional areas can be delineated.

3. Committees to be appointed by the Chairman shall prepare suggested plans of research for these areas within the region.

4. Committees are to be appointed by the Chairman to consider special problems such as control of woody plants and weed control in horticultural crops which are general in scope.

5. It was decided that in 1948 short papers or abstracts with tabular data from individual investigators will be assembled as was done in 1947 and mimeographed copies prepared for limited distribution to research personnel.

6. The abstracts and reports are to be divided between sub-committee chairmen on the same basis as in 1947. Each sub-committee chairman will prepare a summary based upon the reports submitted and append a list of contributors and their affiliated agencies to his summary. All summaries and lists of contributors and their affiliated agencies will be included in the 1948 Proceedings.

7. The Research Committee recommended that a committee of the North Central Weed Control Conference be appointed to work with other weed conferences and agencies in establishing uniform terminology.

8. The Committee recommended that a Conference Editorial Board be appointed.

9. Dr. L. M. Stahler was elected Chairman of the Research Committee for 1948.

10. A vote of appreciation was extended to F. L. Timmons, retiring Chairman, for his services during 1945, 1946 and 1947.

E. D. Witman,
Secretary

PREFACE
TO ASSEMBLED SUB-COMMITTEE REPORTS

F. L. Timmons *

The following assembled report of the Research Committee of the North Central Weed Control Conference is a combination of the separate reports of fourteen sub-committees assigned different phases of weed control research on 2,4-D and other selective herbicides. Each of the sub-committee reports consists of abstracts submitted by individual investigators reporting results in experiments on the control of a specific weed or on a designated phase of the use of herbicides and their effects on weeds or crops. The assembled abstracts are preceded in each case by a regional summary of trends and points of special interest in the individual reports.

The sub-committee reports of results on the various topics are arranged in this combined report in the same order that the sub-committees are listed under "Research Committee Membership and Organization" on the following page. The list of sub-committees can therefore be used as a table of contents of this combined report.

The combined report includes abstracts from 104 investigators, located in 26 states of the United States and 6 provinces of Canada, reporting results of 234 experiments on the various phases of research with 2,4-D and other herbicides. Nearly all of the reports are on results of research conducted in 1946 and 1947. In some cases the abstracts report progress of incomplete experiments on the control of perennial herbaceous or woody species of weeds. Abstracts from nearly all weed research workers in the Conference are included. Thus, this report probably assembles references to and brief reports on most of the weed control research that has been completed during 1946 and 1947 or is underway in the North Central States and Canada. The report on control of woody plants is much wider in scope. Most of the reports from outside of the North Central Conference are on the control of woody plants.

Most of the research reported upon, except that on control of woody plants, followed more or less closely a uniform plan of experiments which has been sponsored by the Research Committee in 1945, 1946 and 1947. The uniform plan, revised each year to provide for new developments, has aided greatly in encouraging new research, in making available to all investigators the pooled judgment and planning of their co-workers, and in coordinating research efforts along definite and productive lines of approach. As a follow-up of this uniform program, a regional plan of interstate cooperative weed research, to be activated under United States Public Law 733, has been prepared by a committee under the leadership of Dr. C. J. Willard, Ohio State University. This plan, if approved and activated, should greatly increase the amount and effectiveness of basic weed research in the North Central States region.

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* Agronomist USDA, Bureau of Plant Industry, Soils and Agricultural Engineering and Chairman of the Research Committee.

RESEARCH COMMITTEE MEMBERSHIP AND ORGANIZATION, 1947

CHAIRMAN: Mr. F. L. Timmons, USDA, Bureau of Plant Industry, Soils and Agricultural Engineering, Hays Experiment Station, Hays, Kansas

VICE-CHAIRMAN: Dr. C. J. Willard, Department of Agronomy, Ohio State University, Columbus 10, Ohio

SUB-COMMITTEES:

Uniform Experiments:

Bindweed (west half of conference) - Mr. Lyle A. Derscheid, Dept. of Agronomy, South Dakota State College, Brookings, South Dakota
Bindweed (east half of conference) - Dr. R. F. Fuellman, Dept. of Agronomy, University of Illinois, Urbana, Illinois
Canada thistle - Dr. A. L. Bakke - Dept. of Botany, Iowa State College, Ames, Iowa
Hoary cress - Mr. J. W. Zahnley, Dept. of Agronomy, Kansas State College, Manhattan, Kansas
Leafy spurge - Mr. H. E. Wood, Weeds Commission, Dept. of Agriculture and Immigration, Winnepeg, Manitoba
Perennial sow thistle - Mr. George Knowles, Dept. of Agriculture, Central Experimental Farm, Ottawa, Canada
Texas blueweed - Mr. W. C. Elder, Dept. of Agronomy, Oklahoma A. & M. College, Stillwater, Oklahoma
All other herbaceous perennial weeds - Dr. K. P. Buchholtz, Dept. of Agronomy, University of Wisconsin, Madison, Wisconsin
Annual and winter annual weeds in small grains, grasses and flax - Dr. L. M. Stahler, USDA, Bureau of Plant Industry, Soils and Agricultural Engineering, Lamberton, Minnesota
Relation of stage of growth in annual weeds to effectiveness of 2,4-D treatment - Mr. O. C Lee, Dept. of Botany, Purdue University, Lafayette, Indiana
Effects of 2,4-D post-emergence treatments on crops - Mr. Glenn Viehmeyer, University of Nebraska Substation, North Platte, Nebraska
Effects of 2,4-D pre-emergence treatments on crops and weeds - Mr. R. S. Dunham, Div. of Agronomy and Plant Genetics, University Farm, St. Paul, Minnesota

Non-uniform Experiments:

Control of woody plants - Dr. L. W. Melander, USDA, Bureau of Entomology & Plant Quarantine, 111 Federal Office Building, Minneapolis, 1, Minnesota
2,4-D and combinations with other methods on annual and herbaceous perennial weeds - Dr. W. C. Dutton, Agricultural Chemicals Section, Dow Chemical Company, Midland, Michigan
Other herbicides - Dr. E. D. Witman, Sherwin-Williams Company, Dept. of Agricultural Chemistry, Ohio State University, Columbus 10, Ohio

OTHER COMMITTEE MEMBERS:

Dr. B. H. Grigsby, Dept. of Botany, Michigan State College, East Lansing
Mr. Noel S. Hanson, Dept. of Agronomy, University of Nebraska, Lincoln
Dr. E. A. Helgeson, Dept. of Botany, North Dakota State College, Fargo
Mr. C. A. Helm, Dept. of Agronomy, University of Missouri, Columbia

OTHER COMMITTEE MEMBERS, Continued:

Mr. A. H. Larson, Div. of Agricultural Botany, University Farm, St. Paul, Minnesota

Mr. G. L. McCall, E. I. DuPont de Nemours Company, Dept. of Agronomy, Kansas State College, Manhattan

Dr. T. K. Pavlychenko, Plant Ecology Laboratory, University of Saskatchewan, Saskatoon, Saskatchewan

Mr. Vernon Woestemeyer, Bindweed Experimental Farm, Canton, Kansas

Dr. W. W. Worzella, Dept. of Agronomy, South Dakota State College, Brookings, South Dakota

RESULTS OF UNIFORM EXPERIMENTS WITH 2,4-D ON BINDWEED (UNIFORM EXPERIMENT NO. I.)

REGIONAL SUMMARY

By: Lyle A. Derscheid

There are several striking observations that can be made from a review of the abstracts submitted. The first and perhaps the most important observation that can be made is the close correlation between good bindweed kills and the good growing conditions. This observation was not reported by all investigators, but it is reported by three men, who seem to be in complete agreement. Timmons, Elder and Derscheid point out that good kills were obtained the fall of 1946 when there was an abundance of soil moisture. Timmons and Derscheid also mention the dry spring of 1946 and Timmons mentions the dry summer of 1946. Treatments made during these dry periods were rather ineffective. Timmons also mentioned the abundance of soil moisture during the summer of 1947 accompanied by what appears to be effective applications of 2,4-D. Helgeson reports more effective control with 2,4-D on fallow land than on grass land and more satisfactory results in eastern North Dakota than in the western areas. There is generally more soil moisture on fallow land than on grass land, and eastern North Dakota usually has more precipitation than the western portion of the state. Elder states that treatments made just before frost resulted in less than a 60 percent kill; whereas Derscheid found that treatments, made two weeks after a late spring frost, resulted in less than a 50 percent kill. Good kills were obtained in the full emergence, bud, full bloom, and fall stages of growth, whenever there was an abundance of soil moisture and provided that treatments were not made shortly before or after a frost.

A review of the various abstracts makes it difficult to determine if one formulation is more effective on field bindweed than another. It appears, however, that when good growing conditions prevail, there is little difference in formulations, but that the ester is slightly more effective in slightly adverse conditions. Timmons' 1946 applications show little difference between formulations in the fall treatments when there was an abundance of moisture, but the ester was more effective for the bud stage when the growing conditions were not as desirable. Woestemeyer reports little difference between formulations for the full emergence and first bud treatments, but his data show the sodium salts to be slightly more effective in the late fall treatment when growing conditions were probably good; the average of the two amines, however, is better than the averages of two sodium salts or three esters for the full bloom applications.

The 1947 applications made by Timmons and by Derscheid show little difference between spray formulations, with the exception of the first bud treatment made by Timmons where the ester appears to be more effective. Helgeson reports that differences between formulations could not be detected in a series of several experiments. Elder and Timmons both report no difference in formulations if two pounds or more are used, whereas Derscheid reports no difference if 1 1/3 pounds are used. Derscheid reports the esters and amines are slightly more effective than the sodium salt when only 2/3 pound was used. It will be noticed, however, that poor results from the sodium salts, in most cases, may be attributed to the fact that mono-hydrate sodium salts were not used. The writer has found that most mono-hydrate sodium salts are more soluble in water, and believes that is an important factor. Mono-hydrate sodium salts were used throughout the year of 1947 and results appear to be better than those obtained in previous years.

Bisal and Ficht agree that there is no difference in effectiveness of formulations when one pound of acid is used on an acre of hedge bindweed (wild morning glory). Ficht, however, indicates that 1/2 pound of ester or amine is more effective than 1/2 pound of sodium salt. This may also be due to the fact that a mono-hydrate sodium salt was not used.

The minimum amount of 2,4-D needed for consistent and effective control of bindweed will depend largely upon growing conditions. One pound of 2,4-D acid appears to be sufficient when growing conditions are favorable. This is borne out primarily by the effective applications made by Timmons and Derscheid in the fall of 1946 and the spring of 1947. Derscheid was able to get effective control with as little as two-thirds of a pound of 2,4-D. The data presented by Pavlychenko indicates that conditions present at the time of application are not known to the writer. Bisal, however, obtained a 100 percent kill with one pound of an ester. Timmons, Elder, and Woestemeyer indicate that there is little advantage in using over two pounds of 2,4-D acid to the acre. When soil moisture was not abundant, however, Timmons did gain more effective elimination by increasing the concentration of all chemicals but the ester. The increase in effect is not great enough to make the kill very satisfactory except where four pounds of amine were used on the bud stage of growth. Helgeson indicates that there is a difference obtained by the use of different rates of appliation, but does not indicate which rate is the most effective.

It would seem, therefore, that favorable growing conditions are of utmost importance. It is also apparent that rate of growth is more important than the stage of growth. If the rate of growth is rapid, one pound of any formulation appears to be effective on field bindweed; in some cases, less than one pound is sufficient. One-half pound of an ester or an amine is sufficient 2,4-D for effective control of hedge bindweed. If the rate of growth is slow, an ester should be used or the dosage of other formulations increased up to somewhere between one and two pounds.

ABSTRACTS

The use of 2,4-D in the control of wild morning glory (Convolvulus americanus (Sims) Greene). Bisal, F.* Treatments with Weedone and Dow 654 carried out on May 7 and 22, 1946, failed to kill the morning glory completely, as indicated by the 1947 results. The treatments were apparently done too early, since many plants emerged after May 22. Treatments carried out on June 14 and

July 16, 1946, after all plants had emerged were 100 percent effective. All the roots were killed to great depth. No regrowth appeared by the end of 1947. Treatments on May 30, 1947, were not entirely effective and regrowth was sprayed again on August 18. Final results will have to be judged in 1948. (*Dominion Soil Research Laboratory, Swift Current, Saskatchewan.)

The use of 2,4-D in the control of field bindweed. Bisal, F.* Treatments with Weedone at the rate of 1 and 2 pounds per acre when weeds were in flower were 100 percent effective. No regrowth whatever appeared in 1947. These treatments were carried out on weeds that were established only a few years previously. Treatments carried out in 1947 were not very satisfactory. However, the poor results may be due to the fact that the area treated was cultivated about four weeks after the spray was applied. Regrowth was sprayed again on September 3 and ultimate results will be observed in 1948. (*Dominion Soil Research Laboratory, Experiment Station, Swift Current, Saskatchewan.)

The relation of growth and rate of application to the effectiveness of different types of 2,4-D formulations for the control of field bindweed. Derscheid, Lyle A., and Stahler, L. M.* A mono-hydrate sodium salt, a triethanolamine, a butyl ester, an isopropyl ester dust, and a sodium salt dust of 2,4-D were compared in duplicate on bindweed at the rates of 5/8, 1 1/4, 1 7/8, and 2 1/2 pounds of 2,4-D acid equivalent per acre. Field bindweed was treated at full emergence, full bloom and fall stages of growth in 1947. Plant stand estimates were made in October of the same year. The "full emergence" treatment was made June 5th when temperatures were around 70 degrees F. and after an unusually wet spring. All treatments except the sodium salt dust appeared to have killed over 90 percent of the original stand. All concentrations of the sodium salt dust produced less than a 50 percent kill. The "full bloom" treatments were made July 22nd after a rainless period of 30 days. The sodium salt dust appeared to be least effective, but otherwise, no difference in chemicals could be noted. The three heavier concentrations of the other chemicals appear to have killed 70-75 percent of the bindweed plants, whereas the lightest concentration eliminated about 60 percent. The "fall treatment" was made September 18th after a long dry spell. Observations in October did not promise a satisfactory kill. (*Assistant Agronomist, South Dakota Agricultural Experiment Station, and Agronomist, USDA, Bureau of Plant Industry, Soils and Agricultural Engineering, respectively.)

The relation of growth and rate of application to the effectiveness of different types of 2,4-D formulations for the control of field bindweed. Derscheid, Lyle A., and Stahler, L. M.* Anhydrous sodium, ammonium, and triethanolamine salts and the ethyl and butyl esters of 2,4-D were compared in duplicated spray applications of 2/3, 1 1/3, 2 and 2/3 pounds of 2,4-D acid equivalent per acre. Field bindweed was treated at full emergence, full bloom and fall stages of growth in 1946. No retreatments were made, but plant counts were made in 1947. The "full emergence" treatment was made May 28th, two weeks after a killing frost, when there was a below average amount of soil moisture. The esters ranked first, followed by the amine with the ammonium and sodium salts the poorest, but no treatments gave better than a 50 percent kill. The "full bloom" treatments were made July 9th when there was an abundance of soil moisture and warm temperatures. The 2/3 pound of ammonium and sodium salts produced an 80-85 percent kill, but all other treatments produced a 90-95 percent kill of bindweed. The fall treatments were made September 11th after having had 7.5 inches of rain the preceding month. An 85-90 percent kill was

obtained by all treatments. (*Assistant Agronomist, South Dakota Agricultural Experiment Station, and Agronomist, USDA, Bureau of Plant Industry, Soils and Agricultural Engineering, respectively.)

Factors influencing the effectiveness of 2,4-D on Bindweeds in 1946. Elder, W. C.* Three types of 2,4-D were used on bindweeds at the rate of 2, 3 and 4 pounds per acre using 1 1/2 gallon of water per sq. rod. Applications were made in spring full emergence, bud stage, in fall after regrowth from summer dormancy and just before killing frosts. Counts made one year after treatment show that there was little difference in results from using amine, salt, and ester types of 2,4-D where 2 pounds per acre or more was used. Ninety percent of the bindweeds were killed by the first fall application. Eighty to ninety percent was eradicated by spring bud stage applications. Applications made just before frost time and at emergence killed less than 60 percent. The first fall stage application was made in 1946 under very favorable conditions. There was plenty of moisture and the bindweeds had made rapid growth since summer dormancy. Conditions were not favorable for fall treatments in 1947, and most years are not favorable for fall treatments. (*Assistant Agronomist, Oklahoma Agricultural Experiment Station.)

The influence of rate of application or dosage of 2,4-D on its effect on Wild Morning Glory (Convolvulus sepium). Ficht, J. T.* Plots 3 rods by 40 rods had 2,4-D applied by a Buffalo turbine sprayer. Silty clay soil described by farmers as loose top. Land was worked with a one way disk June 12th, 1947, treated with 2,4-D July 23rd after ample time had been given for regrowth of weeds. Chemicals used were Chipman's (Sodium salt 60 percent), Naugatuk (Amine 30 percent) and Weed-No-More 40 (Ester 32 percent). Rates with all chemicals were one-half, one, one and one-half and two pounds pure 2,4-D acid per acre. Plots under observation up to October 17th, 1947, showed a quick kill of stems and leaves by Amine and Ester with satisfactory control to October 17th. A very few small plants are developing, but appear to come from slower kill of stems and leaves and a small percentage of regrowth, particularly on the one-half pound treatment. The lightest rates of application were as effective as the heavy rates in the Amine and Ester plots but not in the Sodium salt plot. (*Agronomist, Experiment Station, Swift Current, Saskatchewan.)

Effect of 2,4-D type and dosage on bindweed in the rapid growth first-bud stage. Hanson, Noel S.* An experiment was started on June 3, 1947, in which bindweed (Convulvulus arvensis), was treated at the rapid growth, first-bud stage with amine salt, butyl ester, and sodium salt of 2,4-D at dosages of 1, 2, 3 and 4 pounds per acre. Soil moisture and air temperature at treatment were optimum for rapid growth in the bindweed plants. Each treatment was replicated three times. The first two replications were on moderately high ground and the entire area was in Kentucky bluegrass sod. The third replication was on low ground along a railroad right-of-way. Results of the experiment noted on September 23, 1947, showed that all original topgrowth had been destroyed and some re-emergence was present. In general, poorer kills were noted along the railroad right-of-way than in the bluegrass sod indicating that either re-emergence was slower from the sod or the competition from the grass supplemented control of bindweed by the herbicide. In no case had the plants in either area produced seed except on check plots and fewer blossoms were present in the grassed area on September 23 than along the railroad bed. Percentage reductions in stand were for the most part as good or better at 1 and 2 pounds per acre than

at 3 and 4 pounds per acre. Percentage stand reduction varied from 0 to 99 and was not consistent for type or dosage. (*Assistant Agronomist, Nebraska Agricultural Experiment Station.)

Tolerance of field bindweed in various environments to application of different commercial weedicides. Helgeson, E. A.* Weedicides used in these trials were: (1) Sodium chlorate, (2) Borascu, (3) Dow 70 percent 2,4-D acid with Na_2CO_3 carrier, (4) Dupont's 50 percent ammonium 2,4-D acetate, (5) Sherwin-Williams 40 percent butyl ester of 2,4-D. Field trials indicated that: (1) Chlorate applications gave uniform and excellent control throughout the entire range of the trials, both on grassland and fallow; (2) Borax applications resulted in 90-100 percent control on all fallow plots but no control on grassland plots; (3) 2,4-D acid applications showed varied results, differing mostly with rate of application. In general, however, much better control was obtained on fallow than on grassland and decidedly better control on plots in the eastern half of the State than on those in the western portion of the State; (4) 2,4-D ammonium salt, applied at intermediate and high rates, resulted in little or no control on grassland plots and on those plots in the western portion of the State. Control on those plots in the eastern half of the State varied from 55-100 percent; (5) 2,4-D butyl ester, where applied, resulted in no control in grassland plots, and ranged from 40 percent in the west to 99 percent in the east. (*Experiment conducted cooperatively by L. M. Stahler, Lars Jensen, E. A. Helgeson, and K. L. Blanchard; report submitted by E. A. Helgeson, North Dakota Agricultural Experiment Station.)

Eradication of Field Bindweed (Convulvulus arvensis) by 2,4-D.* Palychenko, T. K. On July 5, 1945. four isolated patches of field bindweed on a heavy clay loam soil were treated at the bloom stage with ethyl ester (Weedone) at three rates: 1000, 1500 and 2000 ppm or 1, 1 1/2 and 2 lbs. of acid equivalent per acre. Results: The records taken one month after the treatment showed a 100 percent kill of the top growth in all plots. The counts taken later in the fall of 1945 showed 42, 6 and 0 percent regrowth in the plots treated with 1, 1 1/2 and 2 lbs. per acre, respectively. A year later in the fall of 1946 the corresponding readings were 61, 2 and 0 percent and in the fall of 1947, 72 14 and 0 percent, respectively. (*Contribution of the Research Laboratory of Plant Ecology, University of Saskatchewan, Saskatoon, Saskatchewan.)

The relation of stage of growth and rate of application to the effectiveness of different types of 2,4-D formulations in eradicating field bindweed. Timmons, F. L.* The sodium and triethanolamine salts of 2,4-D were compared in triplicated spray applications at rates of 1, 2, 3 and 4 pounds of 2,4-D per acre, on bindweed at full emergence, bud, full bloom, and fall stages of growth in 1946. The butyl ester of 2,4-D and 2,4-D acid in carbowax at equivalent rates were included in the comparisons at the bud and fall growth stages. All treatments were repeated on bindweed regrowth in 1947 at the corresponding stages of growth. Spray applications made April 20, May 4, and May 18 at the three earlier stages of growth in 1946 gave about the same results and all were considerably less effective than treatments made October 15. Results from retreatments made at full bloom and bud stages in 1947 were much better than those made at full emergence of bindweed regrowth. Abnormally dry soil early in 1946 and unusually wet soil in the fall of 1946 and spring of 1947 may account for these differences. Heavier rates of application tended to cause greater reductions in bindweed for all formulations except the butyl ester. One pound

of butyl ester per acre was about as effective as any heavier rate, was much more effective than equivalent amounts of the other formulations, and in most cases was somewhat more effective than the heavier rates of the other products. None of the treatments gave complete eradication of bindweed. (*Agronomist, USDA, Bureau of Plant Industry, Soils and Agricultural Engineering Cooperating with the Fort Hays Branch of the Kansas Agricultural Experiment Station.)

The relation of stage of growth and rate of application of different types of 2,4-D formulations in eradicating field bindweed. Timmons, F. L.* Duplicated spray applications comparing the sodium and triethanolamine salts of 2,4-D at 1, 2, 3 and 4 pounds per acre (acid basis) and the butyl ester of 2,4-D at 1/2, 1, 2, and 3 pounds per acre (acid basis) were made on bindweed May 5, May 23 and June 14, 1947, at full emergence, bud, and full bloom stages of growth, respectively. Soil moisture was abundant during April, May, and June, but extreme drought conditions prevailed after early July. Preliminary data on bindweed regrowth recorded four months after the spray treatments in each case show no consistent trend for rate of application or significant differences for types of 2,4-D formulation or stage of growth, except at the bud stage. The sodium salt and the butyl ester were more effective at the bud stage than at full emergence or full bloom but the amine salt was less effective at the bud stage than at other stages except at the heaviest rates. Results with the sodium and amine salts showed a definite trend in favor of heavier rates at the bud stage but butyl ester was about as effective at 1/2 pound per acre as at heavier rates. The butyl ester was more effective than the salts at the bud stage, especially at lighter rates but was no more effective than the salts at any rate of application at other stages of growth. (*Agronomist, USDA, Bureau of Plant Industry, Soils and Agricultural Engineering, Cooperating with the Fort Hays Branch of the Kansas Agricultural Experiment Station.)

The influence of stage of growth, 2,4-D formulation, and concentration of application on field bindweed. Woestemeyer, V. W.* Preparations of 2,4-D were used at concentrations of 1000, 1500 and 2000 ppm and applied at the rate of 1 1/2 gals. per sq. rod at the following stages: full emergence (May 18), appearance of first bud (May 24), full bloom (June 8), summer dormancy (August 9) and late fall (October 15). Results are averages of duplicate plots observed 90 days after treatment, except for summer dormancy, observed 60 days after, and late fall, observed May 5, 1947. Due to erratic appearance of bindweed plants, the first two applications are close together, but differences were observed. Applications made at appearance of first bud gave greatest percent reduction (94), followed by full emergence (91.6), late fall (85.3), full bloom (79.6) with summer dormancy being least effective (19.5). Esters were slightly more effective at full emergence, full bloom, and late fall; salts at appearance of first bud; and acids at summer dormancy. Only minor variations resulted from different concentrations. In most cases, top growth was not completely killed and new shoots emerged within 60 days. Top growth reacted most rapidly to ester types with the acid being only slightly slower. The salts and amines were about equal in giving relatively slow kills. (*Assistant in Agronomy, Kansas Agricultural Experiment Station.)

Killing field bindweed with 2,4-D. Wood, H. E., and Fraser, G. R.* During 1945-47, 78 plots were devoted to this weed, using all formulations at various concentrations, and at all stages of growth. Although the weed was readily killed back to the ground, anything approaching a permanent kill was obtained only when the plant was in full bloom. The table below compares formulations applied to field bindweed in a field of wheat sprayed at three dates, 1946; final observations made August 8, 1947.

Formulation	Acid Concentration	Estimated Reduction in stand in Percent (Date of Treatment & Stage of Growth) June 18 Pre-bud	July 6 Full Bloom	Sept. 13 Post Seeding
Sodium salt-Dow's	.1%	0	5	15
	.2%	45	80	10
Ester - Dow's	.1%	22	87	15
	.2%	75	90	3
Amine Salt - Stantox	.1%	30	45	5
	.2%	90	87	5
Sodium Chlorate	1 lb. sq. yd.	95	95	-

(*Weeds Commission, Manitoba Department of Agriculture.)

RESULTS OF EXPERIMENTS WITH 2,4-D ON FIELD BINDWEED (UNIFORM EXPERIMENT NO. IV.)

REGIONAL SUMMARY

By: Lyle A. Derscheid

The study of the abstracts submitted leaves one without any definite trends to discuss. Growing conditions are not know, formulations are not consistent, and little can be said about the stages of growth or the rates of application.

Timmons submitted two abstracts, and Woestemeyer and Derscheid each submitted one. Timmons and Woestemeyer obtained rather poor results from the original treatment and made retreatments. Derscheid had good results on the original treatment and did not retreat.

In one experiment Timmons used 3 pounds of 2,4-D acid on the original treatment and obtained the poorest results from the esters. A retreatment with 2 pounds produced equal results from amines, esters and sodium salts. In a second experiment, Timmons found the esters to be most effective when 2 pounds were used; the esters were still superior when a retreatment with 1.3 pounds

was made. Woestemeyer reports that the esters and free acid formulations were best when an original treatment of 2 pounds was made; esters and sodium salts were best after retreatments were made. Derscheid could observe no differences as 1 1/3 pounds of all formulations produced 90-95 percent kills.

The esters are more effective in more cases than any other formulation. These data would lead one to think that perhaps the 3 pound treatment of ester made by Timmons was too much to produce an herbicidal reaction. Data from Uniform Experiment No. I. indicate that this is not the case, however.

ABSTRACTS

A comparison of the effectiveness of different commercial preparations of 2,4-D in eradicating bindweed. Derscheid, Lyle A., and Stahler, L. M.* Fourteen commercial 2,4-D products (12 sprays and 2 dusts) were compared in duplicate on undisturbed bindweed at the rate of 1 1/3 and 2 2/3 pounds of 2,4-D acid equivalent to the acre. Applications were made in 1946 when the bindweed was in full bloom; stand counts were made during the summer of 1947. The treatments were made when there was an abundance of soil moisture and warm temperatures. All treatments eliminated between 90 and 95 percent of the original plants; consequently, one chemical appears to be as good as another under these conditions. (*Assistant Agronomist, South Dakota Agricultural College, and Agronomist, USDA, Bureau of Plant Industry, Soils and Agricultural Engineering, respectively.)

A comparison of the effectiveness of different commercial preparations of 2,4-D in eradicating bindweed. Timmons, F. L. * Twenty commercial 2,4-D products were applied as spray at three pounds of 2,4-D per acre on field bindweed in a buffalo grass turf in triplicated treatments made June 5, 1946. Retreatments using the same products in each case at two pounds of 2,4-D per acre were applied October 12, 1946. Bindweed regrowth from the first treatments as recorded September 30, 1946, showed a range of 1 to 41 percent of the original stand with no consistent trend for any type of 2,4-D formulation except that the esters were somewhat less effective. Bindweed regrowth averaged 15 percent for 9 amine salt products, 14 percent for 7 sodium salt products, and 30 percent for 2 esters of 2,4-D. Bindweed regrowth from the second treatment made October 12, 1946, was much reduced for most products when recorded June 12, 1947, but by September 16, 1947, regrowth had increased until it ranged from 2 to 53 percent for the different products. The average regrowth was 22 percent for 9 amine products, 22 percent for 7 sodium salt products, and 28 percent for 2 ester formulations. (*Agronomist, USDA, Bureau of Plant Industry, Soils and Agricultural Engineering, Cooperating with the Fort Hays Branch of the Kansas Agricultural Experiment Station.)

A comparison of the effectiveness of commercial preparations of 2,4-D in eradicating field bindweed. Timmons, F. L.* Twenty different commercial 2,4-D products were applied as sprays and three products applied as dusts, all at the rate of two pounds of 2,4-D per acre in triplicated treatments made October 15, 1946, on a uniform stand and vigorous growth of field bindweed. Retreatments of bindweed regrowth were made at the bud stage June 18, 1947, applying the same product in each case as in the first treatment at 1.3 pounds of 2,4-D per acre. Bindweed regrowth recorded June 10, 1947, averaged 178 plants per square rod for eight amine products, 172 for seven salt preparations, 74 for three esters of 2,4-D and 343 for three 2,4-D dust formulations as compared with 569 plants per square rod on untreated controls. Some of the amine salt sprays gave better

results than others and appeared about as effective as the ester sprays. Bindweed regrowth from retreatments made June 18, 1947, as recorded October 15, averaged 20 plants per square rod for the amine sprays, 23 for the sodium salt sprays, 3 for the ester sprays, and 13 for the 2,4-D dust treatments. Emergence of surviving bindweed plants probably was not complete, due to dry soil conditions and unsufficient time since the retreatments. (*Agronomist, USDA, Bureau of Plant Industry, Soils and Agricultural Engineering, Cooperating with the Fort Hays Branch of the Kansas Agricultural Experiment Station.)

Comparison of commercial preparations of 2,4-D on field bindweed. Woestemeyer, V. W.* Fifteen 2,4-D products, including salt, amine, ester and acid types, were tested on duplicate plots; the 2,4-D in all cases being applied in concentrations of 1000 ppm, 1 1/2 gal. per sq. rd. Treatment was made in rapid growth stage with a few buds present in 1946, and repeated at the same stage and in the same manner on these in 1947. Counts were made 30, 60 and 90 days after treatment each year. On most plots a few new shoots had begun to appear 60 days after treatment. The ester and acid types had somewhat greater reductions in stand than did the salts and amines the first year. In 1947 the salt and ester types averaged a slight additional decrease, while there was a slight average increase in plants on the plots receiving the amine and acid types. With an average original count of about 470 bindweed plants per square rod, the average percent reduction from the 1946 original, in 1946 and 1947 respectively, was for eight salts, 24.98 and 13.20; four amines, 12.70 and 16.97; two esters, 8.45 and 5.95; one acid, 7.80 and 9.70 -- counts taken 90 days after treatment. The composite average reduction for 1946 and 1947 respectively was 13.02 and 13.01. (*Assistant in Agronomy, Kansas Agricultural Experiment Station.)

RESULTS OF UNIFORM EXPERIMENTS WITH 2,4-D ON FIELD BINDWEED (CONVOLVULUS ARVENSIS)

EASTERN STATES REGIONAL SUMMARY

By: R. F. Fuelleman

In the states east of the Mississippi river little difficulty is encountered in killing field bindweed with 2,4-D materials excepting in dry years. In 1947, differences in rainfall between Ohio and Illinois were large. Ohio seemed to have enough moisture during the summer to support competitive vegetation and Doctor Willard stated that he had no difficulty in killing bindweed both "roots and tops". Urbana, Illinois was the center of a drought area, and bindweed grew well and rapidly in corn fields after the corn was "laid by". Observations on areas where 2,4-D chemicals were used in 1945 and 1946 on bindweed disclosed little regrowth.

ABSTRACTS

Killing field bindweed (Convolvulus arvensis). Fuelleman, R. F.* Plots of bindweed in newly seeded grass plots were sprayed with several formulations of 2,4-D using two concentrations of material. The materials used were Chipman's sodium salt -- 1.4 and 2.8 pounds per acre; Esteron (Dow)--1.4 and

2.8 pounds per acre; Weed-No-More 40--(Butyl ester of 2,4-D) 1.4 and 2.8 pounds per acre; and Karme (DuPont) ammonium salt of 2,4-D--also at the rate of 1.4 and 2.8 pounds of 2,4-D acid per acre. The first applications were made on June 5, 1947. All visible bindweed was destroyed within a period of two weeks. The stronger concentrations gave more rapid kill. On July 7 when bindweed was in the early bloom stage, another series was similarly treated. The results were similar to the earlier date, but the killing effect was more rapid, presumably as a result of higher temperatures and less precipitation. Regrowth, before killing frost, consisted of an occasional shoot which apparently escaped the earlier spraying. During late September, field bindweed was sprayed with a concentration of 1000 cc of Butyl ester in 8000 cc of water. Destruction of the top growth was complete within 24 hours. The ultimate effect can be more accurately gauged in the spring of 1948. (*Illinois Agricultural Experiment Station.)

Treatment of field bindweed in corn after the corn is "laid by". Willard, C. J.* When corn is planted in dense field bindweed, the vines will completely cover the ground after the corn is "laid by". This condition existed in an experimental corn field in 1946. Two square rods of such dense bindweed were treated with the butyl ester and the sodium salt of 2,4-D at 4 pounds acid equivalent per acre on August 21. Four similar plots were treated on September 17. In 1947 the plots treated in August showed practically no regrowth. Those treated in September showed only slight regrowth. Unquestionably, there is opportunity for effective reduction of field bindweed population in corn fields by this method. (*Associate in Agronomy, Ohio Agricultural Experiment Station.)

RESULTS OF UNIFORM EXPERIMENTS WITH 2,4-D ON CANADA THISTLE (CIRSIUM ARVENSE (h) SCOP.)

REGIONAL SUMMARY

By: A. L. Bakke*

From the various experimental reports on the destruction of Canada thistle with 2,4-D, it is clear that the Canada thistle plant is in the resistant category. No single treatment with 2,4-D, not even 10,000 parts per million will eradicate Canada thistle. The concentration generally recommended is 1500-2000 ppm wherever it is preferable to get a complete destruction of the above-ground parts over some injury to the associated crop. There is a decided advantage in getting at least two sprayings of 2,4-D during the season, three applications if possible. The results so far show that 2,4-D applications are more effective when applied at the early bud stage. Mowing done at the bud stage followed by two applications the next year have reduced old stands of Canada thistle more than 90 percent. The ester formulations in all cases have been the most effective. Applications made during the early bud stage will stop growing activities -- seed will not be formed. Dusts of 2,4-D can be effectively used in treating Canada thistle patches and individual plants in pastures, grain, and corn fields. Where soil sterilization is not an object sodium chlorate can be used.

Control of Canada thistle with 2,4-D. Bakke, A. L. A heavy stand of Canada thistle was treated with the same amount of 2,4-D in 1945 and 1946. Two sprayings were made each year, the first at the early bud stage and the second in September. In 1947 the thistles were allowed to grow in the brome until the first part of July when the area was mowed. Counts of the number of thistles remaining in each square rod plot were then made in September, 1947, when the whole area was sprayed with Weedone at the rate of 1000 ppm. The results were as follows: DuPont #3-43, Dow A510-44, Carbowax 56, Ammate 4, Sodium Chlorate 0 after the first year. It would then appear as if the eradication of Canada thistle with 2,4-D is generally a two year proposition, at least. Spraying with 2,4-D on Canada thistle in pasture land in northern Iowa generally produced, from two sprayings in one season, a reduction in stand of 70 percent. Mowing prior to blossoming followed by one spraying in September reduced the stand of Canada thistle 40-50 percent. Two sprayings of 2,4-D following the fall application of the previous year reduced the stand about 95 percent. The ester formulations gave the best results. Canada thistle growing in oats was sprayed with one of the ester formulations of 2,4-D when the oats were in the milk stage and again in the stubble. There was a reduction in the stand of at least 90 percent. A heavy stand of Canada thistle was sprayed with an ester formulation in early July when the plants were in the bud stage. About 4 weeks after spraying the infested area was plowed. Up to November no aerial growth had been found. (Contributed by Iowa Agricultural Experiment Station, Ames.)

The use of 2,4-D in the control of Canada thistle (Circium arvense). Bisal, F. Canada thistles treated with 2, 3 and 4 pounds per acre of Dow 510 on May 28, 1946, died down to a depth of 4 or 5 inches. About 50 percent of the plants produced regrowth within a month. The regrowth was sprayed with Weedone at 2, 3 and 4 pounds per acre. This did not kill the plants completely, though a marked reduction in stand was obtained. On September 11, 1947, about 30 percent of the plants had a live root system from 6 inches down. A third treatment might be necessary to kill the remaining plants completely. The results on plots initially sprayed in 1947 were about the same. It was necessary to respray plots that were sprayed on July 8, 1947, but the ultimate results from this treatment cannot be determined until some time in 1948. (Contributed by Dominion Soil Research Laboratory, Swift Current, Sask.)

Use of concentrated 2,4-D sprays in the control of Canada thistles. Buchholtz, K. P.* In 1946 the effectiveness of various quantities of water as vehicle for 2,4-D was studied using Canada thistles as the test plant. Replicated plots were treated with 240, 120 and 60 gallons of spray, application in each spray rate containing 1, 2 and 4 pounds of 2,4-D acid equivalent as the sodium salt. No significant differences in top or leaf kill were obtained for the different spray rates. The higher rates of 2,4-D application significantly increased the speed and completeness of leaf and top kill. In 1947 shoot counts were obtained on the treated plots. No significant differences in shoot reduction were obtained for the different spray rates. The 1, 2 and 4 pound applications gave average shoot reductions of 66, 93 and 96 percent respectively. The 1 pound rate was significantly lower than the other two. A similar experiment was started in 1947 using 120, 60, 30 and 15 gallons per acre applications, all containing 1 pound per acre of 2,4-D acid equivalent as the sodium salt. Thistle injury indexes obtained 7 days after treatment showed no significant

differences. Later observations indicated that top growth kill was nearly equal on all treated plots. (*Department of Agronomy, University of Wisconsin.)

Effect of date and rate of 2,4-D application on the control of Canada thistle. Buchholtz, K. P.* Replicated one-half square rod plots of Canada thistles were treated at the emergence, pre-bud, bloom, regrowth and pre-frost stages of growth with 1, 2, 3 and 4 pounds per acre of 2,4-D acid equivalent as the sodium salt. Checks and plots sprayed at the regrowth and pre-frost dates were mowed when the thistles were in full bloom. Spray applications were made in 1945 and 1946. Thistle shoot counts were obtained before the sprays were applied in 1945 and in the spring of 1946 and 1947. Over the two year period significantly better control was given by the pre-bud application. Reductions in stand obtained in 1947 were 66, 88, 68 and 54 percent for the emergence, pre-bud. bloom and regrowth applications. Plots given the pre-frost application showed an increase in shoot number 40 percent rather than a decrease. During this 2 year period the shoot count on the check plots declined 27 percent. The 1, 2, 3 and 4 pound rates of application gave reductions of 53, 70, 71 and 81 percent respectively. The 1 pound rate is significantly lower than the others. (*Department of Agronomy, University of Wisconsin.)

Relative value of spring and fall 2,4-D treatments in controlling Canada thistles. Buchholtz, K. P.* In 1946 a large infestation of Canada thistles was divided into plots 20 by 40 feet. Thistle shoot counts were obtained soon after complete emergence. Certain plots were treated with 2 pounds and others with 4 pounds of 2,4-D acid equivalent as the sodium salt, using a power sprayer when the thistles reached the pre-dub stage of development. The untreated plots were mowed and certain of them were treated with the 2 and 4 pounds of 2,4-D when the thistle regrowth was about 8 inches high. Certain of the previously treated plots were retreated as well, although growth was not abundant. Shoot counts were made in the spring of 1947 to determine the extent of the injury to the thistles. Statistical analysis of the data was impossible but all treatments were in duplicate and a number in quadruplicate. The shoot numbers on untreated plots mowed at the blossom stage increased an average of 54 percent from 1946 and 1947. The 2 and 4 pounds spring treatments reduced shoot numbers 68 and 34 percent respectively. Two and 4 pound applications in the fall reduced shoot growth 25 and 44 percent respectively. Two and 4 pound applications in both spring and fall resulted in shoot reductions of 83 and 86 percent the following year. Wherever appreciable regrowth occurs following spring application retreatment in the fall seems advisable. (*Dept. of Agronomy, University of Wisconsin.)

Spraying Canada thistle with 2,4-D materials. Fuelleman, R. F., and Slife, F. W. Canada thistles sprayed with butyl ester, methyl ester, sodium and ammonium salts of 2,4-D on May 13, 1947, and retreated July 2 using 2/10 of one percent solutions and mixtures, indicated some resistance. However, the number of shoots per square foot as shown by counts on October 3 were reduced from an average of 15 to 1 1/2 per sq. foot. Flowering plants in the same area sprayed with 2,4-D failed to produce seed. (Contributed by Illinois Agricultural Experiment Station, Urbana.)

Eradication of Canada thistle with 2,4-Dichlorophenoxyacetic Acid. Pavlychenko, T. K.* On August 16, 1946, Canada thistles were treated with ethyl and methyl esters, amine salt and sodium salt of 2,4-D at the rates of 1, 1 1/2 and 2 lbs. in 80 gallons of water per acre. The infestation was solid (400 to 700

plants to a sq. yd.) over an area of 30 acres of drained slough with very deep silt loam. The weeds were in the late bloom stage 3 to 4 feet high. The plots (duplicate) 16 by 200 ft. in size were separated by control plots of the same size. The records on weeds were taken one month after spraying and before the killing fall frost in 1946, and on August 16, 1947. The plots and controls were sown to barley in 1947 and yield records determined. The results were expressed as averages from 8 randomized plots one sq. yd. in size. Results: The original plant population in the ethyl ester plots treated with 1, 1 1/2 and 2 lbs. per acre was reduced by 27, 45 and 57 percent in 1946 and by 66, 81 and 93 in 1947, respectively. The yield of barley from this area was 56.2 bus. per acre. In the methyl ester plots of the corresponding rates the weeds were reduced by 28, 50 and 63 percent in 1946 and 83, 94 and 96 in 1947. The yield from these plots was 57 bushels per acre. Only from 2 to 8 percent reduction in weeds was recorded in the amine salt plots in 1946 and from 3 to 14 in 1947. These plots yielded 3.4 bus. per acre. In the sodium salt plots the reduction of weeds was nil in 1946 and only 1 to 5 percent in 1947 and yield of barley was 1.2 bus. per acre. (*Laboratory of Plant Ecology, University of Saskatchewan, Saskatoon.)

2,4-D on Canada thistle. Willard, C. J. Between 200 and 300 square-rod plots of Canada thistle have been experimentally treated with various formulations of 2,4-D from one to five times in 1945, 1946 and 1947. Unfortunately the 1945 plots could not be continued in later years so we have records of only two years' treatment on the same plots. No treatment, even up to 20 pounds per acre (10,000 ppm) had killed Canada thistle roots at one treatment. Any formulation of 2,4-D at 2, or at the most 3 pounds acid equivalent per acre (1000-1500 ppm) has killed Canada thistle tops. The effect of 2,4-D on Canada thistle is a more effective method of mowing. Sprouts do not come back as quickly when the tops are killed by 2,4-D as they do when they are mowed, nor are the sprouts as vigorous. Nevertheless, there are still sprouts on all plots of Canada thistle that were treated 2 and 3 times in 1946 and twice in 1947. The general appearance of these plots is one of complete eradication and it is probable (though prediction is dangerous) that two treatments in 1948 will complete eradicating the patch. At all events the area has furnished excellent pasture in 1947 where thistles were so dense that it was not pastured at all earlier. The most effective date for the first application on Canada thistles was May 30th when the thistles were in very early bud. Treatments throughout June continued to be reasonably favorable. This was in a wet season. A dry season might have shown different results. Earlier treatments, while effective, resulted in earlier and stronger resprouting than late May and early June treatments. Sprouts appeared in July following all of these treatments. The plots were divided in an attempt to discover the best time for retreatment. This test was not conclusive and the differences were not great. However, those plots which received three treatments in 1946 showed much fewer and weaker sprouts in 1947 than those which received only two treatments. Our recommendations for Canada thistle would be to apply three treatments the first year using 2 pounds acid equivalent per acre of the esters or 3 pounds per acre of the sodium or triethanolamine salts, making the first treatment in bud to early bloom, the second when the sprouts are 4 to 6 inches high in mid-summer, and the third when the sprouts have reappeared in considerable numbers in September. Then apply two treatments each year until eradication is complete. (Contributed by Ohio Agricultural Experiment Station in cooperation with the Dow Chemical Company.)

The use of 2,4-D dusts on Canada thistle and bindweed. Willard, C. J., and Beard, D. F. Though concentrated sprays will tend to replace dusts, there may be a place for dusts in treating Canada thistle and field bindweed in crops because of the much greater penetrating power of the dust. 2,4-D dust has been quite effective in killing the tops of Canada thistles and the roots and tops of field bindweed. Dusts have been satisfactorily used on Canada thistles in pastures, (Canada thistles in a pasture on the University farm have been nearly eradicated in two years by dust treatments only), in oats after they have headed, (a man with a duster can walk into the field and dust patches of Canada thistle and bindweed which are then obvious from the bloom and give them a thorough treatment, which would be more difficult to do with a concentrated spray), in corn fields after the corn is laid by, and along the fence rows where the most favorable conditions dusts have been equal to sprays in effectiveness but they have not been equally effective per unit of 2,4-D as an average. (Contributed by Ohio Agricultural Experiment Station and the Ohio State University in cooperation with the Dow Chemical Company.)

Killing Canada thistle (Cirsium arvense) with 2,4-D. Wood, H. E., and Fraser, G. R. During 1945-47, 64 trial plots of this weed were knapsack sprayed with all formulations, 1 to 2 pounds acid per acre, at all stages of growth. In no instance was a permanent kill obtained. This weed was "killed" back to the ground rather more readily than was sow thistle. Without exception, regrowth the following year was equally as rank and vigorous as on check plots. As with sow thistle, control of this weed in growing crops can be obtained with moderately light concentrations applied at the pre-bud stage. Seed-setting is eliminated and the danger of dissemination by wind is no longer a threat to clean areas. (Contributed by The Weeds Commission, Manitoba Department of Agriculture.)

RESULTS OF UNIFORM EXPERIMENT I WITH 2,4-D ON HOARY CRESS

REGIONAL SUMMARY

By: J. W. Zahnley

Results of experiments with 2,4-D for the control of hoary cress were reported from four locations in Canada and two in the United States. The reports submitted seem to indicate certain trends that merit consideration in an attempt to summarize the results of these experiments. Five of the six reports included in this summary indicate that the esters are more effective than the salts when used at comparable rates of 2,4-D. Quicker action on the weeds, more complete kill of top growth and slower recovery were characteristic results of the esters when comparable rates of salts and esters were used. Two of the reports show that to obtain comparable results, 2,4-D in the form of salts must be applied at a much higher rate than in the esters.

Stage of growth of the weeds is an important factor in determining the effectiveness of 2,4-D. Fall applications appear to be more effective than spring. When spring applications are made, better results are usually obtained when the weeds are in the bud stage. In no case were good kills reported from treatment at full bloom stage or later. Treatment given not later than full bloom at a

rate of one pound per acre, however, prevented the production of viable seed in one experiment.

A study of the following abstracts would seem to justify the following deductions: (1) Hoary cress is moderately resistant to 2,4-D and relatively heavy applications of two to four pounds per acre seem to be desirable. (2) The esters are more effective than the salts or amines. (3) Results of treatments should not be judged too soon. Spring applications should not be evaluated before fall nor fall treatments until well along the following spring. (4) Seed production can be prevented and in time the weed can be eradicated by the proper use of 2,4-D. (5) Applications should be made in the fall or in the spring before bloom stage. Fall treatments appear to be the most effective. (6) Eradication can be accomplished only by repeating the treatments over a period of several seasons.

ABSTRACTS

The use of 2,4-D in the control of hoary cress (Lepidium draba L.) Bisal, F. Plots sprayed with Weedone in 1946 produced no regrowth that season, and it was expected the weed would die out completely. A vigorous regrowth appeared in 1947, however. Plots treated with Weed-no-more 40 in 1947 produced a sickly regrowth within a month. These were retreated on July 10. The tops and roots down to 4-inch depth were killed out completely, though roots remained healthy below this depth. The healthy roots began to produce numerous buds late in the season and it is more than likely the weeds will emerge and grow in 1948. (Contributed by Dominion Soil Research Laboratory, Swift Current, Saskatchewan.)

Killing perennial weeds with 2,4-D, 1947, hoary cress - Lepidium draba. Brown, D. A.* Seventy-seven quarter square rod plots were used and treatments replicated. Stages at which treatments were applied: (a) full emergence, May 16, (b) pre-bud, May 29, full bloom, June 20, fall rosette, September 26. One range of plots was used for repeat sprayings. Formulations used were ester, amine salt and sodium salt, at concentrations of 1 and 2 pounds pure acid per acre in 120 U.S. gallons water. Application was made with a knapsack sprayer. Counts of stand in number of plants were made on permanently staked squares in each plot and percentage stand calculated on the basis of plants per square foot. Results were shown as percentage reduction of original stand plus regrowth. Infestation on the plot area was uniform and dense. Few other weeds appeared until a heavy infestation of wild buckwheat (Polygonum convolvulus) occurred late in the season. Ester gave more rapid kills of top growth. Amine was intermediate and sodium slow in effect but at last reading October 6, sodium appeared to have given equally as good results as the others. Top growth was well killed to the ground at all stages of growth with a slight preference favoring the full bloom stage. Reductions in stand of top growth as at October 6 ranged as follows: Ester 2 pounds acid per acre 82 to 90 percent; Amine 60 to 90 and sodium 30 to 92. Ester 1 pound 65 to 100; Amine 40 to 100; sodium 20 to 90. On the plots receiving repeated sprayings full sprayings were done May 16 and 29 and June 20. Spot spraying of plants remaining were done in September and October. All formulations were equally effective, there being no plants showing above ground in October at the 2-pound concentration and about five percent at 1 pound. Diggings in October showed little killing of roots in the single sprayings but a high percentage of root killing in the repeatedly sprayed plots. (*Assistant Superintendent, Dominion Experimental Farm, Brandon, Manitoba.)

The influence of stage of growth, formulation of 2,4-D and concentration of application (dosage) on perennial weeds. (Uniform Experiment I-1). Friesen, H. A.* All formulations, regardless of concentration, resulted in almost complete killing of the top growth of hoary cress when the spraying was done at the first bud, or rapidly growing stage. At the fully emerged stage, very good kills of the top growth resulted from the use of the ester at all concentrations, but the amine and sodium salt gave good kills only at the higher concentrations. All formulations, except the ester at the two pound per acre rate, resulted in poor kills at the flowering stage. Hoary cress, treated in the full flowering stage all unaffected plants set seed. Root killing did not appear to be extensive especially when the treatments were made in the fully emerged or flowering stages. At these stages regrowth was in evidence some six weeks after treatment, and twelve weeks after treatment regrowth ranged from thirty to eighty percent of the original stand. Plots treated with the sodium and amine salts tended to show the quickest as well as the most complete recovery. Plots sprayed in the fall of 1947, at the fall rosette, pre-frost and after the first fall frost stages showed almost complete wilting of the top growth at all formulations and concentrations. With the exception of the three fall treatments, seasonal conditions were unfavorable for 2,4-D work. The spring of 1947 was exceptionally cold and dry, resulting in only a very slow growth of both weeds and crop during May and June. July and August were very hot and dry thus again adversely affecting the action of the 2,4-D. (*Assistant in Field Husbandry, Department of Agriculture, Dominion Experimental Station, Scott, Saskatchewan.)

Effect of different dosages of butyl ester of 2,4-D on hoary cress. Hanson, Noel S.* An experiment was started on May 8, 1946, in which four different dosages of butyl ester were applied to hoary cress, (Lepidium draba), when the plants were in the rapid-growth, first-bud stage. Dosages were at 1, 2, 3 and 4 pounds per [illegible] The plots were replicated three times. Observations on May 31, 1947, showed an average reduction in stand of 99, 96, 98 and 98 percent for the dosages of 1, 2, 3 and 4 pounds of acid equivalent, respectively. Four plots showed complete reduction in stand with no plants visible. Later observations showed no recovery, indicating complete eradication. (*Assistant Agronomist, Nebraska Experiment Station, Lincoln.)

The influence of stage of growth, formulation of 2,4-D and concentration of application on Lens-podded hoary cress (Cardaria draba var. repens (Schrenk) O. E. Schulz (Uniform Experiment I-1). Sexsmith, J. J. Tests in duplicate, conducted at Dalroy Substation 16 miles east of Calgary, Alberta, were set up in 1946 using four formulations of 2,4-D and four concentrations of application, at five growth stages. Retreatments were given to all plots of one replicate in 1947, using the same rates as original treatments, when the cress was between the bud and full bloom stages of growth. Top growth kills of from 5 percent to 100 percent resulted from the single treatment, the greater kills resulting from the ester and the amine salt at 3 and 4 pounds per acre. Amount of regrowth varied greatly, being as low as 1 to 3 percent for the amine and ester at the higher concentrations. Production of viable seed was prevented by treatments given not later than full bloom at a rate of one pound per acre. Best results were from treatments made at the bud stage. Plots that had received the single treatment (1946) were seemingly back to the condition of untreated areas by October 1947, but differences due to the various rates and formulations were not very marked. Under conditions similar to those prevailing in these tests, it seems doubtful if 2,4-D will kill lens-podded hoary cress.

However, 2,4-D may prove useful, in conjunction with cultural and cropping practices, in bringing about complete eradication. (Contributed by Experimental Farm Service, Dominion Department of Agriculture, Experimental Station, Lethbridge, Alberta.)

The effectiveness of different types of 2,4-D formulations at different rates of application in eradicating hoary cress (NCWCC Uniform Exp. No. 1-3, 1946). Timmons, F. L.* Triplicated spray applications on hoary cress (Lepidium draba) were made April 12, 1946, comparing the sodium salt, triethanolamine salt, and ethyl ester of 2,4-D at 2, 3 and 4 pounds of 2,4-D per acre and the butyl ester of 2,4-D at 2, 3 and 4 pounds of ester per acre (1.6, 2.4 and 3.2 pounds of 2,4-D). The hoary cress was in bud to early bloom when sprayed. The spray treatments were repeated on the same plots October 22, 1946, on hoary cress regrowth which was in the rosette stage and making vigorous growth. The regrowth of hoary cress from the first treatments averaged 17, 31, 83 and 93 percent, respectively, for the ethyl ester, butyl ester, sodium salt and triethanolamine salt with the heavier rates of application giving better results than lighter rates in the case of the esters. Results from the retreatments made on fall regrowth were much more satisfactory with all four chemicals. The percentages of regrowth from retreatments at 3 pounds per acre were 3.4, 9.5, 16.8 and 17.1, respectively, for the ethyl ester, butyl ester, sodium salt and amine salt. The percentages of regrowth from treatments at 4 pounds per acre were 1.2, 8.3, 5.0 and 12.6, respectively, for the same chemicals. The salts of 2,4-D were entirely ineffective on hoary cress in the spring applications and gave comparable results with the esters in the fall applications only when applied at rates twice as great. (*Agronomist, Bureau of Plant Industry, Soils and Agricultural Engineering, USDA, cooperating with Fort Hays Branch of the Kansas Agricultural Experiment Station.)

The effect of different types of 2,4-D and rates of application on hoary cress in grass sod and in cultivated land. Zahnley, J. W.* Hoary cress in bluegrass and in bromegrass sod and in cultivated land was treated with different formulations and rates of 2,4-D. Four applications have been made in the grass sod May and September 1945, April 1946, and May 1947. Sodium salts at rates of 1.92, 2.88, 3.88 and 4.32 pounds of 2,4-D per acre showed progressively greater effectiveness as the rate increased to 4.32 pounds per acre for the first two applications. Reduction in stand by 4.32 pounds of sodium salt was practically the same as with 1.92 pounds of butyl ester after three applications of each. The difference in effectiveness of the different rates of sodium salt and the superiority of the esters became less pronounced after the second treatment. Fall applications of both sodium salt and ester were more effective than those made in the spring. For the first three treatments the sodium salts reduced the stand 94 percent and the esters 97 percent. The fourth treatment, May 14, 1947, consisted of a uniform application of butyl ester of one series and isopropyl ester to the other. On October 22, 1947 in bluegrass, appeared to be completely eradicated, and only a trace of plants were found on the remaining plots. Duplicate treatments were made on hoary cress in cultivated land May 3, 1946 and October 1, 1946, using three types of 2,4-D formulations and methoxone. On May 2, 1947 the reduction in percent stand of hoary cress by each type was esters 90, triethanolamine 63, sodium salt 54 and methoxone 75. All plots were treated with the ester May 14, 1947. On October 15 the regrowth consisted of only 9 plants found on one plot originally treated with triethanolamine. No regrowth appeared on any of the other plots. This low count may be due in part to the extreme drouth in late summer and fall which doubtless

retarded regrowth. It appears however that hoary cress can be eradicated by repeated treatments with 2,4-D. (*Agronomist, Kansas Agricultural Experiment Station, Manhattan, Kansas.)

RESULTS OF UNIFORM EXPERIMENTS WITH 2,4-D ON LEAFY SPURGE (EUPHORBIA ESULA)

REGIONAL SUMMARY

By: H. E. Wood*

Top growth of leafy spurge can be almost completely destroyed by the application of 2 pounds and upward acid per acre, however, even at heavier concentrations (4 pounds, and occasionally higher), and after repeat applications, the root system a few inches below the surface remains alive and continues to send up new shoots. Repeat treatments, especially when initial treatment is made at time plants are blooming, results often in marked reduction in stand. Sodium salt is less effective in destroying top growth than the esters or amine salts; oil where substituted for water gives no better results.

ABSTRACTS

The use of 2,4-D in the control of leafy spurge. Bisal, F. Treatments with 2,4-D have been unsatisfactory to date in that regrowth of plants has always occurred. Since spraying with 2,4-D was started in 1945, the area has been seeded to crested wheat grass, but the leafy spurge has continued to spread. The soil is a fine sandy loam. Spraying with the various formulations of 2,4-D has resulted in the killing of tops and roots to a depth of 1 to 3 inches, but regrowth has always occurred. This regrowth has taken from 1 to 3 months to appear. One area was sprayed three times in 1947, regrowth appearing after the first and second spraying and the condition of the roots indicate that regrowth will occur in 1948. One spraying in 1947 was made with 2 pounds 2,4-D and 4 gallons diesel fuel per acre, but this was neither more nor less effective than when water was used in the spray. (Contributed by Dominion Soil Research Laboratory, Swift Current, Saskatchewan, Canada.)

Killing Leafy spurge with 2,4-D, 1947. Brown, D. A. Seventy-seven quarter square rod plots were used and treatments replicated. Stages at which treatments were applied: (a) full emergence, May 21, (b) pre-bud, June 6, (c) full bloom, August 23, (d) fall rosette, September 23. One range of plots was used for repeat sprayings. Formulations used were ester, amine salt, and sodium salt, at concentrations of 1 and 2 pounds pure acid per acre in 120 U. S. gals. water. Application was made with a knapsack sprayer. Counts of stand in number of plants were made on permanently staked squares in each plot and percentage stand calculated on the basis of plants per square foot. Results were shown as percentage reduction of original stand plus regrowth. Infestation on the plot area was uniform and dense. When final readings were made October 4, regrowth was fairly heavy and uniform over all plots except those treated September 23 (fall

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Weeds Commission, Manitoba Department of Agriculture
* Winnipeg, Canada.

rosette). On these top growth had been killed off. In the May, June and August applications ester at 2 pounds pure acid per acre showed a reduction in stand of from 40 to 67 percent, amine 54 to 67, and sodium 59 to 68. At 1 lb. per acre ester ranged from 27 to 63 percent reduction in stand, amine 37 to 58 and sodium 36 to 66. On plots sprayed repeatedly at all stages up to August ester at 2 pounds gave an average reduction in stand of 98 percent, amine 73 to 88 and sodium 67 to 76. Diggings in October showed little root killing in the single treatments at any of the stages, but the repeated sprayings gave root kills extimates at 45 percent. In 1946, plots were treated at three stages during the season. Single treatments showed less than 10 percent reduction in stand when read in late September 1947, but sprayings repeated three times showed 60 percent reduction in stand. (Contributed by Dominion Experimental Farm, Brandon, Manitoba.)

The effect of concentration of 2,4-D on leafy spurge at one stage of growth. Leggett, H. W. It would appear that the amine and ester applications which give a quick kill of the top growth reduce the percent stand of leafy spurge materially. There is no chance for the plants to recover during ideal growing conditions as was apparently the case with the sodium salt treated plots. The leafy spurge roots of both amine and ester treated plots in all concentrations were more seriously damaged than those of the sodium salt plots. While a scattering of buds on the roots of leafy spurge were affected by the sodium salt applications and these only in the 3 and 4 pound concentrations, those buds affected in the amine and ester formulations increased with the concentration and tapered off as the distance from the crown increased. The maximum length of root damage being 4 inches. The foliage was dense in the original stand, but in the regrowth the foliage was light and the stems weak and spindly in all plots. The seed production on all plots was noticeably reduced when compared with the check plot. This was very evident as the treated plots showed only sterile flowers at freeze-up. The density of the grass increased in the plots which killed quickly regardless of concentration of formulation. (Contributed by Dominion Experimental Station, Lacombe, Alberta, Canada.)

Use of 2,4-D for eradication leafy spurge. Pavlychenko, T. K. During 1946, four formulations of 2,4-D were applied as sprays at three concentrations to heavily infested plots of leafy spurge, near Balgonie, Saskatchewan. Plots were replicated three times; were treated at various stages of growth; two series were retreated once, one series retreated twice. The results indicate that one treatment in June was ineffective, as in some plots the weed population a year later was much higher than before treatment. Plots treated in June (pre-bud) and retreated (one series June 19; another July 19; and August 22) apparently were adversely affected by the June treatment as reduction in stand was only slight. Very marked reduction in stand followed single treatment in July (full bloom) and likewise where July treated plots were retreated in late August. (Contributed by Laboratory of Plant Ecology, University of Saskatchewan, Saskatoon, Saskatchewan.)

Killing leafy spurge (Euphorbia esula) with 2,4-D. Wood, H. E, and Fraser, G. R. During 1945-47, approximately 250 plots were devoted to trials with leafy spurge on heavy clay soil near Winnipeg, and on light loam at Winkler. All formulations at concentrations from 1 pound to 10 pounds acid per acre were applied from spring to fall; more than half the plots received one or more retreatments. No difficulty was experienced in killing top growth (except with light concentrations of sodium salt). In no instance was complete eradi-

cation observed; on plots retreated a measure of "thinning out" was evident. The difficulty in treating this plant with 2,4-D appears to be a matter of translocation into the root system. There is some ground for assuming that leafy spurge is more susceptible to 2,4-D in the flowering to seed-setting stage (mid-summer) than at other stages of growth. (Contributed by Weeds Commission, Manitoba Department of Agriculture, Winnipeg, Canada.)

RESULTS OF UNIFORM EXPERIMENTS WITH 2,4-D ON PERENNIAL SOW THISTLE

REGIONAL SUMMARY

By: Geo. Knowles*

Abstracts were received from Beaverlodge, Alberta; Scott, Saskatchewan; Winnipeg, Manitoba; and Kapuskasing, Ontario.

In Manitoba the best kill of top growth of perennial sow thistle was obtained when 2,4-D was applied at the advanced flowering to seeding stage of growth. At the three other points where this experiment was conducted, best kills of top growth were obtained when the applications were made during the rapid growth stage.

All experimenters obtained better results from the ester and amine formulations than from the same amounts of sodium salts. One and a half pounds of 2,4-D per acre in the ester form appears to be sufficient to kill the top growth of perennial sow thistle. Heavier rates of amine and sodium salts were required to obtain the same results. No one treatment gave complete eradication of perennial sow thistle.

Since three out of four experimenters obtained the best kill of top growth by applying 2,4-D in the rapid growth stage it would appear to be practical to control this weed in oats, wheat, barley and in crops not susceptible to injury from 2,4-D.

ABSTRACTS

Results of uniform experiments with 2,4-D on perennial sow thistle. Carder, A. C. Compared to the untreated checks, all treatments greatly reduced the thistle population at the end of two seasons. Some formulations were much more effective than others. The esters were highly effective. The amines were reasonably effective at the stronger concentrations. Sodium salts were the least effective. A .1 percent of an ester applied at the rate of 1 1/2 gallons per square rod was almost as effective as higher rates of the same formulation. Perennial sow thistle was most vulnerable to attack by 2,4-D when in the rapid growth stage. The value of retreatments was strikingly illustrated and the necessity of continuing applications over more than one year was very apparent. (Contributed by Dominion Experimental Farm, Beaverlodge, Alberta.)

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Results of uniform experiments with 2,4-D on perennial sow thistle. Friesen, H. A. Extensive killing of the top growth of perennial sow thistle was observed when this weed was treated, with sixteen, twenty-four, and thirty-two ounces of 2,4-D per acre, in the bud stage. Eight ounces of 2,4-D per acre resulted in poor kills. The ester type applied at 24 to 32 ounces per acre, resulted in 98 percent of the top growth being destroyed. The amine and sodium salt types at these dosages were approximately 6 and 10 percent less effective. Regrowth, three months after treatment, was only an estimated 2 percent of the original stand on plots treated with 24 ounces per acre of the ester as compared with 10 percent regrowth on plots treated with an equal dosage of the amine and the sodium salt. Regrowth ranging up to 40 percent was observed on plots treated with only 8 ounces of 2,4-D per acre. With the exception of the ester type at 32 ounces per acre, all formulations and dosages gave poor kills, when the treatments were made at the fully emerged stage. All formulations at dosages of 8 and 16 ounces per acre permitted an estimated 40 to 60 percent of the treated plants to flower and set seed. Regrowth was observed to be very abundant three months after treatment on all plots treated in the fully emerged stage. (Contributed by Dominion Experimental Farm, Scott, Saskatchewan.)

Results of uniform experiment with 2,4-D on perennial sow thistle. Wiancko, W. R. Judging from the results of two years' experiments at Kapuskasing, the best time to apply 2,4-D for perennial sow thistle eradication is when this weed is in first bud. One application is not enough, but when the same treatment is repeated at the same time in the following year the eradication is almost 100 percent effective. The ester formulation was the most effective followed by amine and sodium salts in this order. A concentration of 1000 ppm at the rate of 1 1/2 gallons per acre of an ester was just as effective as heavier rates of the same formulation, sodium and amine salts gave higher percentage kill as the concentrations increased. (Contributed by Dominion Experimental Farm, Kapuskasing, Ontario.)

Killing perennial sow thistle (Sonchus arvensis) with 2,4-D. Wood, H.E., and Fraser, G. R. During 1945-47, 90 trial plots of this weed were knapsack sprayed with all formulations, 1 to 2 pounds acid per acre, at all stages of growth. This weed was killed back to the ground (ester and amine salts giving better results than sodium salts) with 1 1/2 to 2 pounds acid per acre. Best kills were obtained when the weed was treated in the advanced flower to seeding stage. While concentrations around 1 pound acid per acre will give a measure of control of sow thistle in a growing crop, the fact that emergence is rather late presents a problem of how best to treat this weed in a grain crop well advanced in stage of growth. (Contributed by Manitoba Department of Agriculture, Winnipeg, Manitoba.)

RESULTS OF APPLYING 2,4-D TO MISCELLANEOUS HERBACEOUS WEEDS

REGIONAL SUMMARY

By: K. P. Buchholtz

Poverty weed was eradicated in several instances by using 2,4-D sprays. Most effective results occurred when applications of ester preparations were applied in mid summer to the weed growing in sandy soil. The amine, ammonium

and sodium salt preparations were inferior, sometimes decidedly so, to the esters in all cases where comparisons were made. In one case poor kills were obtained on an infestation in heavy soil while eradication occurred on plots on sandy soil. Applications of 2 pounds of 2,4-D per acre appear most suitable.

No cases of eradication of Russian knapweed were reported even after three applications of 2,4-D in one case. Top growth was killed consistently by applying 2 pounds per acre of an ester preparation. Less regrowth occurred after pre-bud treatments than after full bloom treatments.

Gumweed was killed by all formulations over a wide range of concentrations at all stages of growth. A 5 percent amine salt dust gave nearly complete kills but Agroxone was less successful.

Ester preparations killed the top growth of bladder campion when applied at from 2 to 4 pounds per acre. Sodium and amine salts were less effective in killing top growth Nearly normal regrowth occurred the year after treatment regardless of the preparation, rate or stage of growth treated.

Applications of 1 and 4 pounds per acre of the butyl ester deformed but did not kill wild parsnip plants in the blossom stage. Eight pounds per acre of the ester was effective in destroying them, however.

The top growth of field horsetail in the sterile stage was killed in several instances by applying as little as one-half pound of 2,4-D as the ester or amine salt during the summer months.

Massive applications of the isopropyl and butyl esters of 2,4-D reduced but did not eradicate quack grass. Plots treated 4 times at 2 week intervals with 10.7 pounds per acre of several esters, showed less than 10 percent of normal growth after the last treatment. All plots recovered rapidly after treatment was stopped.

ABSTRACTS

The use of 2,4-D in the control of poverty weed (Iva axillaris pursh). Bisal, F. Treatments carried out on dryland in midsummer of 1946 were very effective, killing the plants and destroying the roots entirely, but treatments earlier in the season reduced the infestation only by 50 to 60 percent. Treatments carried out on July 17, 1947, on irrigated land, killed all top growth and roots down to about 6 inches. No regrowth appeared that year. Ultimate results would have to be judged in 1948. (Contributed by Dominion Soil Research Laboratory, Swift Current, Saskatchewan.)

The use of hormone-like herbicides in the control of Russian knapweed (Centaurea picris pall). Bisal, F. Complete kill of tops and roots to a depth of 6 inches was obtained soon after spraying with Weedone and Standag in June 1945. By October of that year, however, a regrowth of about 50 percent of the original number appeared. This regrowth was sprayed with "Weed-no-more 40" in June, killing 95 percent of the plants down to 2 or 3 inches. A second fairly healthy regrowth appeared within a month. The area was sprayed again with the same chemical and rate of application on July 14, 1947. There is no indication that the weed has been killed with this final application. The new regrowth appears

to have a higher resistance to the chemical than the old. (Contributed by Dominion Soil Research Laboratory, Swift Current, Saskatchewan.)

Killing Russian knapweed (Centaurea repens) with 2,4-D. Brown, D. A. A small patch was secured for treatment near Hartney, Manitoba. Plots one-quarter square rod in size were used and butyl and isopropyl ester were applied at 2 pounds acid per acre. Treatments in duplicate were made at the pre-bud stage (June 6, 1947) and full bloom (June 25). Additional plots were used for repeated sprayings on the same dates. Applications were made with a knapsack sprayer using 120 U. S. gallons water per acre. Final readings were made on September 24. At the pre-bud stage butyl ester had reduced the stand above ground by 95 percent and isopropyl ester 97, and at full bloom 80 and 85 percent respectively. On the repeat sprayings both treatments had reduced top growth 97 percent. Diggings showed that about 50 percent of roots were killed in the pre-bud single spraying treatment, 20 percent in the full bloom treatment and 75 percent in the plots sprayed twice. The pre-bud sprayings done in bright, dry weather at a temperature of 72 degrees F. were much more effective than the full bloom sprayings done in moist but bright weather at a temperature of 85 degrees F. (Contributed by Dominion Experimental Farm, Brandon, Manitoba.)

Killing bladder campion (Silene latifolia) with 2,4-D. Brown, D. A. A heavy infestation was treated in 1946 with ester, amine and sodium salt at concentrations of 4 lbs. and 2 lbs. acid per acre. Applications were made at full bloom and post bloom stages (June 26 and July 5) by use of a knapsack sprayer, at the rate of 120 U. S. gal. of water per acre. Esters cut back all top growth to the ground within one week. Amines reduced the stand 75 percent and sodium salts 60 percent. Regrowth came thickly in September and readings June 15, 1947 indicated almost 100 percent regrowth in all formulations, concentrations and stages of treatment. (Contributed by Dominion Experimental Farm, Brandon, Manitoba.)

The influence of rate of application of 2,4-D on poverty weed (Iva axillaris). Ficht, J. P. Plots at Eston, Saskatchewan, were treated July 8th, 1947, with Chipman's (Sodium salt 60 percent), Naugatuk (Amine 30 percent) and Weed-No-More 40 (Ester 32 percent) at rates from 1/2 to 2 pounds of pure 2,4-D per acre. Observations up to September 24th indicated a slow kill of leaves and stems on all plots especially at the lighter rates of application. Land was worked once one month before spraying and tillage operations resumed July 27th. Although results appeared disappointing on this area at first, the last observation indicated only a small amount of regrowth on any of the plots. The remainder of the field received two extra tillage operations but showed a considerable amount of regrowth. Results are inconclusive as to determination of desirable rates of application, but indicate the range may be wide enough for experimental work with this weed, although early observations indicated heavier applications should be tried. (Contributed by Dominion Experimental Station, Swift Current, Saskatchewan, Canada.)

Effect of 2,4-D on wild parsnips. Neville, Homer B., and Willard, C. J. Wild parsnips at the blossom stage were sprayed with the butyl ester of 2,4-D. At the rate of 4 pounds of 2,4-D acid per acre the plants were badly deformed and seeding prevented. At 8 pounds per acre the plants were killed. A pasture containing a great quantity of wild parsnip was sprayed with concentrated butyl ester spray at the rate of 1 pound per acre of 2,4-D acid. The parsnips

were 30 inches tall and in bud. The plants were deformed but not killed. Within a week after treatment, cattle had grazed most of the sprayed plants to 6 to 12 inch stubs but had not touched the unsprayed parsnips. (Contributed by Ohio Agricultural Experiment Station in cooperation with the Sherwin-Williams Company.)

Eradication of poverty weed (Iva axillaris) by 2,4-D. Pavlychenko, T. K. In July 1945 isolated patches of poverty weed (ave. infestation 227 stems to a sq. yd.) grown on sandy loam and heavy clay loam soils, were treated at the blooming stage with the ethyl ester of 2,4-D (Weedone), at the rate of 1 1/2 lbs. of acid equivalent per acre. The weed reacted very erratically. The infestation on sandy loam was permanently eradicated with one application. That on the heavy clay loam was slightly reduced but almost fully recovered in 1946 and 1947. In 1947 tests were repeated at the same stage on the heavy clay loam but four different chemicals were used, butyl ester, amine salt, sodium salt and free acid. The butyl ester killed the top growth but some regrowth occurred late in the fall. The other preparations were less effective failing to kill all top growth and allowing more regrowth. (Contributed by Laboratory of Plant Ecology, University of Saskatchewan.)

Effect of 2,4-D on Russian knapweed (Centaurea repens). Pavlychenko, T. K. In July 1945 a portion of a solid infestation (102 stems to a sq. yd.) on a heavy clay loam was isolated by deep trenches filled with soil sterilized by sodium chlorate. The isolated area was treated with ethyl ester (Weedone) 1500 ppm (1½ lbs. acid eq./ac.) at the bloom stage. Results: In 45 days the top growth was 100 percent killed. Counts taken late in the fall of 1945, 1946 and on June 13, 1947 showed some regrowth but not more than 1 or 2 percent of the original stand. On June 13, 1947 the initial treatment was repeated and the results of both treatments by the late fall of 1947 were a regrowth of only .2 percent of the original stand. (Contributed by Laboratory of Plant Ecology, University of Saskatchewan.)

Using 2,4-D on Quack grass. Willard, C. J., and Neville, Homer B. Quack grass has repeatedly withstood single applications of 20 pounds per acre (10,000 ppm) of 2,4-D acid in either the sodium salt or ester form. The bad results of repeated applications of 2,4-D to lawns suggested that repeated applications might eradicate quack. An experiment was laid out, starting April 23 in vigorous quack grass, to treat quack grass with the iso-propyl and butyl esters of 2,4-D at the rate of 4, 8, and 16* pounds per acre of acid two, three and four times, at intervals of 1, 2 and 3 weeks. The 2-week interval caused more damage than the one-week or 3-week intervals. The plots treated 4 times at 16 pounds of acid per acre at a 2-week interval were reduced to less than 10 percent of normal growth on June 18th. However, by August the plots were recovering strongly, so there was no eradication, even by these expensive applications. On the acid basis used, the butyl ester was slightly but perceptibly more effective than the iso-propyl ester. (Contributed by Ohio Agricultural Experiment Station in cooperation with Dow Chemical Company and Sherwin-Williams Company.)

Killing field horsetail (Equisetum arvense) with 2,4-D. Wood, H. E., and Fraser, G. R. Although no plots were devoted solely to this weed in the

* Corrected from the report distributed at Topeka by the authors.

"fertile stem" stage, it was met with frequently in other plots. The plant "killed" to the ground very readily with the several formulations at various concentrations, although the effect upon the root is not known. On August 29, 1947, two 3-acre plots densely infested with horsetail, in the "sterile stage" two to six inches in height, on heavy clay loam soil under summer fallow, were machine sprayed, 20 gallons water per acre, one with Esteron 44 at 1 pound, the other Stantox amine salt at 1/2 pound acid per acre. When checked a month later growth on both plots was killed back to ground level. (Contributed by The Weeds Commission, Manitoba Department of Agriculture.)

Killing gumweed (Grindelia squarrosa) with 2,4-D. Wood, H. E., and Fraser, G. R. During 1945-47, 30 plots were devoted to trials on gumweed - a bad pasture weed. All formulations at a wide range of concentration were used on all stages of growth. Results showed perfect or almost perfect kills in all cases. In 1946, two plots were dusted - one with a 5 percent amine salt dust; the other with Agroxone (a product of Imperial Chemical Industries). The amine dust gave an almost perfect kill; the Agroxone, 75 percent kill. (Contributed by The Weeds Commission, Manitoba Department of Agriculture.)

Killing poverty weed (Iva axillaris) with 2,4-D. Wood, H. E., and Stevenson, D.S. Four densely infested plots of poverty weed, in the flowering stage (9" high), were knapsack sprayed at a concentration of .2 percent acid, August 15, 1946. Two months after application the ester preparations were found to have killed the top growth completely and prevented regrowth. The ammonium and amine salt preparations had reduced the stand 18 and 65 percent respectively. In September of 1947 the plots treated with the ester showed only 4 percent of the original stand while the plots treated with the salts had nearly complete recovery. (Contributed by The Weeds Commission, Manitoba Department of Agriculture.)

RESULTS OF UNIFORM EXPERIMENTS ON RATE OF APPLYING 2,4-D AND OTHER SELECTIVE HERBICIDES ON ANNUAL WEEDS IN CEREALS, GRASSES OR FLAX

REGIONAL SUMMARY

By: L. M. Stahler*

Reported data of experiments using 2,4-D and dinitro herbicides to control annual or biennial weeds in cereal grains, flax and grasses definitely establish 2,4-D as an efficient new aid to the grain farmer in the North Central area. Experimental evidence, results of field use, and new developments in airplane and low volume spray application of 2,4-D predict a greatly expanded use of this selective herbicide in 1948 and succeeding years and a decline in the use of the dinitro compounds.

Despite expanded research and field use of 2,4-D, several important considerations in regard to its use must be more definitely established before we

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can make clear cut recommendations with assurance. The relative merits and hazards of the several common forms of 2,4-D; the ester, amines and sodium salts, cannot be clearly defined from abstracts of data available. Likewise, optimum levels of application sufficient to control weeds with a minimum of injury to the growing crop cannot be derived from data on hand.

The variability in data of abstracts is largely due to lack of uniformity in materials and methods used in the reported experiments and the wide range of field conditions under which they were applied. It is well known that the several commercial forms of sodium salt of 2,4-D vary greatly in efficiency -- the older mixed salts being less efficient than the newer soluble monohydrate forms. Reports indicating a poor kill of annual weeds by the sodium salts were almost invariably from experimenter using the old, insoluble forms. The tolerance of crops to the sodium salts, likewise, is not truly reflected by data derived from treatment with an insoluble salt.

The broad leaved annual weeds commonly infesting spring planted cereals, flax and grasses are mostly susceptible to 2,4-D at rates of application below the level detrimental to the crops. Mustards, Frenchweed, sunflower, ragweeds, marshelder, pigweeds, lambsquarters, cocklebur and similar species, when treated in late seedling stage have been consistently controlled by reported applications of from one-fourth to one-half pounds 2,4-D acid per acre in the form of esters, amines and soluble sodium salts. When the older partly soluble forms of sodium salt were used, one-half to three-fourths pounds 2,4-D acid per acre were required. In cereal grains-oats, wheat and barley, these rates of application at the full tiller stage of growth have as an average of all data submitted, increased yields of harvested grain and had no detrimental effect on germination of the grain seed.

Certain, more tolerant weeds commonly infesting spring grains and flax, such as wild buckwheat, Russian thistle, wild lettuce; are indicated as requiring at least one-half pound 2,4-D acid per acre for elimination under most favorable conditions; i.e., while in the rapidly growing post-seedling stage. Applications of one-fourth to one-half pound 2,4-D acid per acre have consistently controlled these weeds--stunting growth and preventing seed formation. Reported data indicating poor control of these species, as well as the more susceptible species previously discussed, were invariably from applications made when the weeds were in a late stage of development; i.e. bud to full bloom. At the later stages of development weeds have already done most of their potential damage to their companion crops, are proven to be more tolerant of 2,4-D, and grain is more sensitive to the herbicide. For these reasons data indicating late applications has not been given equal weight with data from experiments applied at more practical stages of development, in determining regional summaries.

Flax is indicated to be less tolerant of 2,4-D than the cereal crops, but control of the susceptible broad leaved annuals that are associated with its culture are successfully reported by several contributors. Annual weeds are killed or controlled by one-fourth to one-half pounds 2,4-D acid per acre, applied when flax is two to four inches high without marked injury to the crop. Higher rates of applications are indicated to be hazardous at all stages of growth.

A few reports on grasses indicate that 2,4-D can be safely used to control all susceptible species of annual and winter annual weeds associated with these

crops without marked reduction in seed or forage yield. Rates of application of one-fourth to one and one-half pounds 2,4-D acid per acre are reported as used successfully. Buffalo grass is an exception to the general rule being sensitive to high rates of application of 2,4-D. Application on all grasses, when weeds are small and before seed heads appear on the grass, are reported as optimum in weed kill with minimum damage to the grass crop.

From the abstract data, it is evident that the ester formulations tested have quite consistently given better control of weeds under all conditions of application, and likewise more severe damage to oats, wheat, barley and flax, than other formulations of 2,4-D at comparable rates of application. Data are not consistent enough to justify specific recommendations for rates of application for each specific formulation of 2,4-D. On the basis of the data submitted it appears logical to recommend that the ester formulations be used at the lower level under best conditions of applications and at the maximum level where conditions are not optimum.

ABSTRACTS

Chemical control of weeds in flax. Bakke, A. L. Previously Sinox and Dow Selective in dilute concentrations have been recommended as herbicides for the control of annuals in flax. The Sherwin-Williams Company of Cleveland, Ohio, manufacturers of Weed-No-More cooperated with the Iowa Agricultural Experiment station in ascertaining whether a dilute solution of Weed-No-More could not be used. Concentrations of Weed-No-More 40 ranging from 1/8 of a pint to one pint per acre in 100 gallons of water were used to spray flax at Kanawha, Iowa, where Pennsylvania smart weed infestation was heavy. The results were as follows: 1/8 pint-22.86 bushels per acre, 1/4 pint-18.45 bushels, 1/2 pint-20.68 bushels, and one pint-17.25 bushels, as compared with untreated check - 17.15 bushels. Sinox W. in the recommended concentration yielded 14.76 bushels per acre, Dow Selective 18.76 bushels. Santobrite (sodium pentachlorophenate) 1/2 percent yielded 18.86 bushels. From the date gotten at Kanawha, Iowa, it is evident that a dilute solution of Weed-No-More (butyl ester) can be used to control weeds like the Pennsylvania smart weed. At Crystal Lake, Iowa, Dow Selective yielded 22.19 bushels per acre, Santobrite (1/2 percent) 24.22 bushels and the control 1.2 bushels. (Contributed by Iowa Agricultural Experiment Station.)

Spraying oats with 2,4-D. Bakke, A. L. Oats (Clinton) 8-10 inches tall heavily infested with Pennsylvania smart weed and other annuals was sprayed with various chemicals. The data have been recorded in the following table:

Chemical used	Concentration 100 gals.	Weight per bushel	Yield per acre bushels
Weed-No-More 40	1/8 pint	36.5	74.02
Weed-No-More 40	1/4 pint	38.0	66.84
Weed-No-More 40	1/2 pint	37.6	58.11
Weed-No-More 40	1 pint	37.8	55.29
Weed-No-More 40	10 gals. per acre	37.2	61.29
No treatment	Control	37.4	67.53
Sinox W	4 pints	38.2	57.29
Santobrite (Sodium penta-	4 lbs.	37.7	69.93
Santobrite chlorophena)	2 lbs.	36.0	68.93
Tufor 40	1 quart	36.6	93.94
Dow-Sodium salt	20 oz.	36.8	95.03

Solutions as dilute as 1/8 pint of Weed-No-More controlled the annual weeds in oats. Oats sprayed with the amine formulation (Tufor 40-one quart) gave higher yields than the control; the same was true for the sodium salt (Dow). (Contributed by Iowa Agricultural Experiment Station.)

Killing annual and winter annual weeds in grain crops with 2,4-D. 1947. Brown, D. A. Areas of wheat, oats, barley and flax known to be infested with many common annual weeds were laid out into 130 half-square-rod plots to provide replicates of each concentration and formulation of ester, amine salt, sodium salt and a 2,4-D dust. Treatments were applied with a knapsack sprayer at concentrations of 4, 8, and 16 ounces of acid in 120 U. S. gals. of water per acre. Grain was six inches high and weeds in the four leaf to budding stage at time of spraying and dusting. Wild mustard (Brassica arvensis)was 98 percent killed by all formulations and concentrations of spray but dust gave poor results. Other weeds present and kills in percent by sprays were lambsquarters (Chenopodium album) 75, Frenchweed (Thlaspi arvense) 90, red root (Amaranthus retroflexus) 80. Dust made poor kills in every case. Weeds not killed by any treatment were wild buckwheat (polygonum convolvulus), stickly cockle (Silene noctiflora). Wheat yields were significantly higher on sprayed and dusted plots, barley slightly higher, and oats slightly lower than untreated plots. All treatments significantly reduced flax yields. Ester at 1 lb. and 8 oz. was particularly severe on flax plants, but all formulations at 4 oz. showed little injurious effect. (Contributed by Dominion Experimental Farm, Brandon, Manitoba.)

Killing annual and winter annual weeds in flax crop with 2,4-D. 1947. Brown, D. A. A low pressure 16-foot boom sprayer was used to apply ester, amine salt and sodium salt on 1/8 acre replicated plots of flax in a field that was very heavily infested with wild mustard (Brassica arvense) and green foxtail (Setaria viridis). All formulations were applied at 8 oz. acid per acre in approximately 85 U. S. gal. of water. Almost complete kills were obtained from all three formulations of common mustard, but green foxtail and a light infestation of sticky cockle (Silene noctiflora) remained uninjured. Assuming the yield from check plots as 100 percent, ester treated plots gave 163 percent, amine salt 164 and sodium salt 130. Ester gave a thicker, but retarded growth of flax and distinct malformations of bolls. Amine and sodium salts also held back maturity, but injury was slight. The significant increase in

yield from all formulations was possibly in large part due to the timely killing of mustard that ran as high as 165 plants per sq. ft. As the season advanced green foxtail which remained uninjured was afforded a better chance to grow on treated plots and by harvest time it was obviously more prominent in the treated than the check plots. (Contributed by Dominion Experimental Farm, Brandon, Manitoba.)

Response of Koto flax to applications of 2,4-D. 1/ Dunham, R. S. 2/ Koto flax was sown in row plots with rows 12 inches apart, so that weeds could be controlled by hoeing. Treatments consisted of spraying with the sodium salt, amine salt, and ester of 2,4-D at 4 oz., 12 oz., and 24 oz. of acid equivalent per acre and at plant stages of 2 inches, pre-bud, late bud, and full bloom. Check plots were sprayed with equal amounts of water. All rates and stages were included in a block for each chemical to reduct danger of drifting. The individual plots of rates included three rows; the center one received the treatment and was harvested for yield, the two outside rows were borders for protection against drift. A separate sprayer was used for each formulation. The plots were replicated 4 times and carried on at St. Paul and Waseca. Sprayed at the 2-inch stage and at 4 oz., there was no significant reduction in yield for any formulation. At 12 oz. the ester appeared injurious although reductions in seed yields were not significant at the 5% point. All formulations appeared injurious at 24 oz. At pre-bud the ester was injurious at 4 oz. and the amine at 12 oz. Germination tests showed no injury to the viability of the seed harvested from plots treated at these stages. From the trial by Tandon and Dunham it is known that Koto is one of the more tolerant varieties. Applications were made at late stages primarily to determine any effect on the genetic constitution of the crop. This information will be available next season. Oil percentages and iodine numbers will be available later this year.

(1/ Paper No. 609 of the Miscel. Journal Series, Minnesota Agricultural Experiment Station)

(2/ Agronomist, University of Minnesota, St. Paul, Division of Agronomy and Plant Genetics in cooperation with Sherwin-Williams Company)

Rate of applying 2,4-D on annuals and winter annual weeds in cereals and flax. Ficht, J. P. Chemicals used were Chipman's (Sodium salt 60 percent), Naugatuk (Amine 30 percent), Weed-No-More 40 (Ester 32 percent). All were used at one-quarter and one-half pound pure 2,4-D per acre. The weeds present were: tumbling mustard (Sysimbrium altissimum), stinkweed (Thlaspi arvense), flaxweed (Sophia multifida), Russian thistle (Salsola pestifer), lambsquarter (Chenopodium album). The one-quarter pound per acre rate of application resulted in satisfactory kills of tumbling mustard, stinkweed and lambsquarter in all cases where the amine or ester were used. The one-quarter pound rate with the sodium salt was inclined to be slow and gave incomplete kills. Flaxweed and Russian thistle were distinctly more resistant than the others, but in early stages of growth (about 3 inches high) they were satisfactorily destroyed by the amine and ester at one-half pound per acre. Results with the sodium salt at one-half pound per acre were not entirely satisfactory but inconclusive due to uneven distribution by the turbine mist sprayer which was used. (Contributed by Dominion Experimental Station, Swift Current, Saskatchewan, Canada.)

Rate of applying 2,4-D and other selective herbicides on annual and winter annual weeds in cereals and flax. Friesen, H. A.* Plots of Rescue wheat, Ajax

oats, Prospect barley, Prolific spring rye and Royal flax were used in this test. Eleven treatments, involving the three types of 2,4-D at each of the three concentrations outlined in this experiment were used, as well as a five percent sodium salt dust at eight pounds per acre and Sinox at one gallon per acre. Because of the abnormally cold dry spring the germination of the weed seeds was so much delayed that practically free of seeds. Observations and weed counts showed no significant differences between the treated and untreated plots. Observable damage to the crops as a result of the treatments was confined to oats, where the eight and sixteen ounce per acre rate of the butyl ester resulted in a lodged appearance of the crop. Some plants were also found to have thick short internodes and club-like panicles. The treatments did not significantly affect the yields of wheat, oats, barley or spring rye. The results were quite striking with flax. Because of delayed seeding, stinkweed, lambsquarter, wild buckwheat and especially Russian thistle were abundant. The stinkweed and lambsquarters were controlled by all formulations and rates. Russian thistle was controlled quite effectively by the eight and sixteen ounce rates of the ester and the sixteen ounce rate of the amine. Yields on these plots were approximately four times as great as the yields on the other treatments and the checks. The eight and sixteen ounce rates delayed maturity in flax from 8 to 10 days as compared with the check. Wild buckwheat was not effectively controlled by any of the treatments. (*Assistant in Field Husbandry, Dominion Experimental Station, Scott, Saskatchewan.)

Herbicidal possibilities of 2,4-Dichlorophenoxyacetic acid in flax. Pavlychenko, T. K. Extensive tests with various 2,4-D dusts on flax were made at Saskatoon in 1947. The soil was a heavy clay loam. The spring was dry, cold and late and the summer dry and cool. Principal weeds were: stinkweed (Thlaspi arvense), Russian thistle (Salsola kali), wild mustard (Sinapis arvensis), tumble weed (Amaranthus graecizans), lambsquarter (Chenopodium album), and red root pigweed (Amaranthus retroflexus). Plots were 20 by 140 feet in size. The following chemicals were used as dusts at the rate of 6 ounces of acid equivalent per acre: 5 percent butyl, methyl and isopropyl esters; 5 percent triethanolamine; 3 and 5 percent sodium salt; 5 percent free acid and 5 percent Killoweed (free acid). The weeds were rank, in the bud or flowering stage. Their density was from 700 to 1100 plants to a sq. yd. The flax was small and very patchy, but healthy. It offered an excellent material for studying its resistance to the chemicals but was insufficient for yield determinations. The crop successfully resisted all the chemicals and produced apparently normal seed. Sodium salts caused no damage but the isopropyl ester temporarily coiled the crop. The weeds were affected as follows: wild mustard was killed 100 percent by all esters; 91 percent by the amine salt; 28 to 69 percent by the sodium salts and 93 to 100 percent by the free acid dusts. The chemicals were from 2 to 20 percent less effective on the stinkweed. Lambsquarters were destroyed from 70 to 93 percent by the amine salt, esters and the free acid but only from 0 to 19 percent by sodium salts. Russian thistle, red-root, pigweed and tumble weed were only set back by esters and free acids but almost totally resisted sodium and amine salts. (Contributed by Laboratory of Plant Ecology, University of Saskatchewan, Saskatoon, Saskatchewan.)

Effect of 2,4-Dichlorophenoxyacetic acid upon annual weeds and grain yields. Pavlychenko, T. K. The ester, amine and sodium salt groups of 2,4-D were tested in the dry prairie regions of Saskatchewan to control annual weeds in grain crops. Heavy clay, heavy clay loam, silt loam and sandy loam soils were included in widely separated districts. The chemicals were used at the

rates of 4, 8, 12 and 16 ounces of the acid equivalent in 10 gallons of water per acre, at temperatures of 60 to 78 degrees F, with weeds in a pre-bud stage. The principal weeds were: At Regina, wild mustard (Sinapis arvensis); at Saskatoon, stinkweed (Thlaspi arvense), wild mustard and Russian thistle, (Salsola kali); at Cavell, stinkweed, Russian thistle and hare's ear mustard (Coringia orientalis); at Young, wild mustard, stinkweed and cow cockle (Saponaria vaccaria). Plots were 3300 sq. ft. and the data mentioned herein are averages of 8 randomized one sq. yd. samples.

Results: The weeds susceptible to 2,4-D were controlled 90 to 100 percent by esters; 73 to 100 by amine salts and 63 to 88 by sodium salts. The kinds of chemicals and the stages of weed growth were more important than the rates used. Grain yields were significantly increased in most plots. Commercial grades were not affected. Occasional deformations occurred on heads and leaves, particularly of young tillers (lax or club spikes and 2-3 bladed leaves). These occurred more frequently in crops treated early (3-4 inches high) and seldom in those more advanced (previous to heading). All annual weeds developed ever-increasing resistance from the flowering to maturity. (Contributed by Laboratory of Plant Ecology, University of Saskatchewan, Saskatoon.)

Use of Sinox W for controlling annual weeds in grain crops. Pavlychenko, T. K. In 1947 experiments with Sinox W were carried out throughout the dry prairie region,the prairie-forest transition zone and the park belt of Saskatchewan. All major soil types from heavy clay to sandy loam, were included. Plots were from 3300 sq. ft. to 2.4 acres. The treatments were made with 4, 6 and 8 pts. in 80 gallons of water per acre. The principal weeds in the crops treated were wild mustard (Sinapis arvensis), stinkweed (Thlaspi arvense), Russian thistle (Salsola kali), Russian thistle (Salsola kali), lambsquarters (Chenopodium album), wild buckwheat (Polygonum convolvulus) and hare's ear mustard (Coringia orientalis). Results: Young seedlings (4 to 12 leaf stage) of the wild mustard, stinkweed, and Russian thistle were effectively controlled. Hare's ear mustard and lambsquarters of the same age were seriously injured with a tendency to recover. Wilk buckwheat generally escaped injury from lighter applications (4 pts.) but was set back by stronger doses (6-8 pts.). Unlike 2,4-D, Sinox if applied at the above rates and at temperatures below 80 degrees F had no other effect on crops than a slight leaf burning. This generally had a stimulating rather than harmful effect on yield. The chemical was most effective where the soil was heavy, the stand of crop uniform, the ground moisture before the treatment plentiful and the growing conditions after the treatment favorable. Otherwise, the treated plots were frequently reinfested with weeds and benefits from the initial destruction of weeds considerably lost. Under favorable growing conditions the gains in yield ranged from 9 to 41, and under dry conditions from 1 to 2 bus./ac. (Contributed by Laboratory of Plant Ecology, University of Saskatchewan, Saskatoon.)

Rate of applying 2,4-D in several forms to annual weeds in spring barley at Crookston, Minnesota. Stahler, L. M. and Dunham, R. S.* Spray applications of the butyl ester, triethanolamine, and monohydrate sodium salt of 2,4-D, at 1/4, 1/2, and 3/4 pound acid per acre were made on triplicate, randomized, 1/25 acre plots of Mars barley on June 25, 1947. Applications were made with an experimental model field sprayer. Applications were at a uniform rate of 10 gallons per acre. Barley was uneven, 5 to 16 inches high and in the shooting to boot stage. Barley was heavily infested with sow thistle in rosette to shooting stage, mustard in rosette to bloom and buckwheat in 4 leaf to twining stage.

Also heavy infestation of wild oats. Soil moisture was ample throughout the season. All formulations at all concentrations gave practically 100% elimination of mustard and wild buckwheat. Sow thistle was controlled -- did not bloom -- on all treated plots but final kill cannot be determined until spring of 1948. At lowest rates of application of all formulations some buckwheat was not completely killed but was completely controlled and produced no seed. Sow thistle deteriorated very slowly at lower rates of application, and reacted to all ester formulations more rapidly than to the amines or sodium salts. Barley on plots treated with esters at 1/2 and 3/4 pound was markedly dwarfed in height and head size. Yields of barley were reduced by all formulations at 3/4 pound per acre -- the esters cutting yields almost 50%. Average yields of plots treated with 1/2 pound of all formulations were only slightly reduced; at rates of 1/4 pound per acre were only equal to untreated check plot yields. Quality of barley as measured by bushel weight was not affected by any treatment. Germination tests of barley seed are not yet available. (*Agronomist, Bureau Plant Ind., Soils and Agric. Engr., USDA, and Professor, Agronomy Division, College of Agric., University of Minnesota, St. Paul, Minnesota.)

Rates of applying several forms of 2,4-D for the control of annual weeds in Durum wheat. Stahler, L. M. and Helgeson, E.A.* Spray applications of the butyl ester, triethanolamine salt and monohydrate sodium salt of 2,4-D at 1/4, 1/2, and 3/4 pound acid per acre were made on triplicate, randomized, 1/25 acre plots of durum wheat on June 23, 1947. Applications were made with an experimental model field sprayer. Applications were at a uniform rate of 10 gallons per acre. Wheat was 4 to 8 inches tall, mustard in 2 leaf to first bud, Frenchweed in 2 leaf to first bud, buckwheat 1 to 4 leaf stage, lambsquarters 4 to 6 leaf stage. Grain and weeds in rapid growing stage at date of treatment. Following treatment soil was very dry to harvest. All formulations at all rates of application gave practically 100% elimination of mustard, Frenchweed, buckwheat and lambsquarters. Some buckwheat at lowest rates of application of all formulations remained partly green but was dwarfed and did not produce seed. Wheat on all plots, except the two higher rates of the butyl ester was slightly taller than the untreated check plots where the heavy infestation of weeds coupled with the drought conditions dwarfed the plants and reduced the yield of wheat. Wheat on plots treated with 1/2 or 3/4 pound of butyl ester showed dwarfing of stems and shorter heads than untreated areas. Wheat yields were increased by all treatments, the increases ranging from 90 to 120 percent more than the untreated checks. Applications of 1/4 pound per acre of all formulations gave highest average yield increase. Quality of wheat as reflected in bushel weight, was not effected by any of the treatments. Germination data are not yet available. (*Agronomist, Bureau Plant Industry, Soils & Agricultural Engineering, USDA, and Head of Botany Dept., Agricultural Experiment Station, Fargo, North Dakota, respectively.)

Response of flax varieties to 2,4-D. 1/ Tandon, R. K. and Dunham, R. S. 2/ This study was designed to determine if there is any differential response between seven commonly grown varieties of flax to applications of the sodium salt, the amine salt, and the ester of 2,4-D at rates of 4, 8, and 16 ozs., acid equivalent per acre. The varieties tried were: Crystal, Dakota, Koto, Minerva, Redwing, Sheyenne, and B 5128. There were four replications making a total of 336 plots. The plots consisted of three 18-foot rows of which a 16-foot length of central row was harvested for the yield of grain and straw. The rows were sown 1 ft. apart so that weeds could be controlled by hoeing. The herbicides were sprayed when the plants were 5 to 8 inches tall. Data collected consisted

of growth rate, blooming and maturity dates, degree and percentage of lodging, and yield of grain and straw. Germination tests and determination of oil percentage and iodine values are in progress. A statistical analysis of the data has not been completed at this time but varietal differences are indicated with a trend toward greater tolerance in Redwing and Koto and greater susceptibility in Crystal and B 5128. Minerva, Dakota, and Sheyenne occupy an intermediate position. Straw yields and agronomic data are not available at this time.

(1/ Paper No. 112 of the Miscl. Journal Series, Minn. Agr. Exp. Station.)
(2/ Graduate student and Professor, respectively.)

Rate of applying 2,4-D and other selective herbicides on annual weeds in oats and flax. Taylor, D. K. Selective herbicide applications on replicated plots of oats and flax have given disappointing results on certain weeds at the rates used. The main weeds corn spurrey (Spergula arvensis L.), lady's thumb (Polygonum persicaria L.) and wild buckwheat (Polygonum convolvulus L.) were poorly controlled by various preparations of 2,4-D at rates up to 1 lb. 2,4-D acid per acre. There were indications that the dinitro sprays at the recommended rates were more successful than 2,4-D in the control of these weeds. Although some treatments gave increased yields of grain and straw over the check none of these were significantly higher at the 5% level. The ester and dust forms of 2,4-D at 0.5 and 1.0 lb. 2,4-D acid per acre caused noticeable damage to the flax. Considerable leaf tip damage to the oat plants was evident immediately after spraying with ammonium dinitro secondary butyl phenate, however recovery seemed complete within a month. (Contributed by Dominion Experimental Farm, Agassiz, B.C., Canada.)

Rate of applying 2,4-D and other selective herbicides for the control of annual weeds in winter barley. Timmons, F. L.* Spray applications of the triethanolamine salt and the isopropyl ester of 2,4-D at 1/4, 1/2, and 1 pound per acre (acid basis) and of Dow Selective Herbicide at 2.2 pounds of dinitro salt per acre were made May 13, 1947, on a thin stand of Reno winter barley. The crop was 4-6 inches tall and heavily infested with Russian thistle, rough pigweed, sunflower, and lambsquarters in early stages of growth. All treatments were replicated five times. The ester of 2,4-D gave better kills of weeds and retarded the growth of barley more than did the amine salt. The percentages of weeds killed by the ester at 1/4 pound per acre were 74, 77, 94 and 100, respectively, of Russian thistle, pigweed, sunflower, and lambsquarters, as compared with 32, 50, 70, and 82, respectively, for the amine at 1/4 pound per acre. Dow Selective Herbicide gave excellent kills of all four weeds but severely burned the barley foliage. Barley yields averaged 58.9 bushels per acre for the amine salt treatments, 56.5 for the ester treatments, and 49.9 for Dow Selective Herbicide as compared with 55 bushels per acre for the untreated controls. The highest yields were 62.4 bushels per acre for the amine at 1 pound per acre and 59.2 for the ester at 1/2 pound per acre. More important than the small increases in yield due to 2,4-D was the fact that harvesting the crop with a combine was possible only on sprayed areas where the weeds had been controlled. (*Agronomist, Bureau of Plant Industry, Soils and Agricultural Engineering, USDA, cooperating with the Fort Hays Branch of the Kansas Agricultural Experiment Station.)

Effect of various dosages of 2,4-D on five species of winter annual weeds growing in intermediate wheatgrass. Viehmeyer, Glenn.* Field scale applica-

tion of four formulations of 2,4-D, amine and sodium salts and butyl and ethyl esters, at .8, .4, .2, and .1 pound per acre was made May 14-16, 1947, on wild lettuce (Lactuca scariola L.), fleabane (Erigeron canadense L.), evening primrose (Oenothera spp.), stick-seed (Lappula spp.), and annual peppergrass (Lepidium apetalum). Weather was cool and light precipitation occurred on the nights of May 14, 16 and 18. At time of treatment stage of growth was for lettuce, rapid growing prebud; fleabane, rapid growing prebud; primrose, first bloom; stick-seed, bud; peppergrass, full bloom; and wheatgrass, early jointing. Minimum effective dosages were for lettuce, .1 lb. ester, .4 lb. salt; fleabane, .1 ester, .4 salt; stickseed, .2 ester, no control by salt; primrose, .1 ester, .1 salt; peppergrass, .2 ester, .8 salt; and wheatgrass, no injury from any application. Under conditions prevailing at the time the esters were approximately four times as effective as the salts on the five species of weeds treated. The greater toxicity of the esters may be, in part, due to unfavorable weather conditions at application but not all difference was chargeable to this factor. This conclusion is supported by many other experiments with both weeds and crops. The experiment indicates that dosages of the esters lower than those generally recommended are effective in controlling the weeds named. (*Horticulturist, University of Nebraska Sub-Station, North Platte, Nebraska.)

Killing weeds in plots of wheat, oats, barley and flax with 2,4-D. Wood, H. E. and Fraser, G. R. Square rod plots of wheat, oats, barley and flax were treated at four locations. The four crops were seeded side by side on land known to contain a heavy infestation of annual weed seeds. Three formulations -- sodium salt, ester, and amine salt -- were applied with knapsack sprayer at concentrations of 4, 8, and 16 ounces acid in water, 120 U.S. gals. per acre; also a dust of 2,4-D was applied at similar acid concentrations, when the grain was 6 to 10 inches in height, the weeds two leaves to budding. Almost complete eradication of the predominating weed, wild mustard (Brassica arvensis), was obtained throughout with the sprays. Dusts at 4 ounces gave less satisfactory kills. At the 4 ounce concentration, sodium salt and the dusts were likewise less satisfactory on the other weed growth, which included giant ragweed (Ambrosia trifida), stinkweed (Thlaspi arvense), lambsquarters (Chenopodium album), red-root pigweed (Amaranthus retroflexus). Wild buckwheat (Polygonum convolvulus) showed slight "stunting". The effect on the grain crops, even at the highest concentration was slight; flax appeared to be retarded rather severely at the 8 and 16 ounce concentrations, particularly with the ester; severe burning of the leaves and twisting of the stem was quite evident. No yield data were taken from these plots. (Contributed by The Weeds Commission, Manitoba Department of Agriculture, Winnipeg, Manitoba.)

Killing weeds in fields of wheat, oats, barley and flax with 2,4-D. Wood, H. E. and Fraser, G. R. Supplementary to plot trials were strips one rod wide, 20 rods long, in fields of wheat, oats, barley and flax, at the same four locations as the plots. A boom sprayer was used to apply the same three formulations at 8 ounces acid in 20 U. S. gallons water per acre. Weed infestation was comparable to, and control similar to that obtained in the plots. Three randomized blocks of ten rows, ten feet in length, from both treated strips and checks were threshed and yields determined. With two minor exceptions, yield increases were obtained from all treated wheat and flax fields; oats and barley yields were so contradictory that no conclusions could be drawn (these two crops throughout the area gave "spotty" yields). Range of yield increases for wheat and flax, basis 100 for checks, was:

	Sodium Salt	Ester	Amine Salt
Wheat	103 to 153	105 to 120	90 to 167
Flax	95 to 129	99 to 142	135 to 188

(Contributed by The Weeds Commission, Manitoba Department of Agriculture, Winnipeg, Manitoba.)

RESULTS OF UNIFORM EXPERIMENT III - THE RELATIVE SUSCEPTIBILITY TO 2,4-D OF ANNUAL AND WINTER ANNUALS AT DIFFERENT STAGES OF GROWTH

REGIONAL SUMMARY

Oliver C. Lee and L. F. Bewick 1/

Reports submitted indicate the following trends:

1. Weeds were most susceptible to 2,4-D at early stages of growth. Their resistance increased gradually with growth and maturity with a sharp increase in resistance noted after the bud stage.

2. Little difference could be determined between the effectiveness of the different formulations of 2,4-D when applied at early stages of growth. However, the esters showed an increase in effectiveness over the salts in direct relation to the maturity of the weed.

ABSTRACTS

Stinkweed (Thlaspi arvense). Carder, A. C.* Treatments were applied to a heavy infestation of stinkweed (Thlaspi arvense) in growing spring wheat. Applications were made under as favorable conditions as possible, though these were never entirely optimum. Low humidity and relatively low temperatures prevailed at the time of the first two treatments. Plots were duplicated. The most effective treatments were secured when the weed was in a seedling stage of several true leaves, or at least before budding. The ester formulation was, in every instance, the most effective, though at the earlier growth stages of the weed its advantage was very slight over the sodium salt. Possibly the more rapid action of the ester accounts for its greater effectiveness over the salt when both were applied at the later stages of growth. Somewhat better kills were obtained by the .1 percent, or heavier concentration. (*Assistant, Department of Agriculture, Alberta, Canada.)

Effect of seven different type formulations of 2,4-D at six dosage levels on plant kill and seed formation of cocklebur (Xanthium commune). Hanson, Noel S. and Shafer, Neal E.* An experiment was conducted at Lincoln, Nebraska, to determine the lowest efficient dosage possible for the eradication or the prevention of seed set of cocklebur plants. Two replications of plants in the young bur-forming stage were treated on August 28 and 30, 1947. Five different

1/ Extension Botanist, Purdue University, Research Fellow, Ohio State University, respectively.

ester formulations, one triethanolamine, and one sodium salt formulation were tested at six dosage levels of 1/8, 1/4, 1/2, 1, 1½ and 2 pounds acid equivalent per acre. Observations 24 hours after treatment showed typical 2,4-D curvature on all plots but most intense at the higher dosages. Observations on October 15th indicated average kills of 85 percent or above on all plots treated with 1/2 pound or more per acre. Several kills of 90 percent or more were obtained on plots treated with 1/8 and 1/4 pounds per acre. These kills were not consistent in both replications and, consequently, do not appear in the averaged data. Good control was obtained at 1/8 and 1/4 pounds per acre expressed in reduced bur set. No attempt was made to determine the reduction in burs on live plants, but mature burs were later collected from these plants and seed set determined. Twenty-five burs were cut open and seed counted. Few seeds were formed at dosages of 1/2 pound per acre or above. At 1/8 pound per acre an average of from 13.5 to 22.5 burs out of 25 had no seed, but 2.5 to 8.5 burs had one seed formed, and from 0.5 to 2.0 burs out of 25 had two seed set. The untreated plants had 22.0 percent of the burs with no seed, 34.0 percent with one seed, and 43.0 percent with two seeds. (*Assistant Agronomist and Graduate Assistant, Nebraska Experiment Station, Lincoln, respectively.)

The relative susceptibility to 2,4-D of three annual weeds at different stages of growth. Lee, Oliver, C.* Applications of esters and sodium salt of 2,4-D were made at rates of .25, .5, 1.0, and 1.5 pounds per acre (acid basis) on common ragweed (Ambrosia elatior), giant ragweed (Ambrosia trifida), and cockle bur (Xanthium commune) in four stages of growth. The ester produced a quicker kill of all species in all stages of growth than did the sodium salt. In the early stages of growth lesser amounts of the ester were required for complete kills. In the seedling and rapid growth stages both species of ragweed were quite consistently killed with .5 pounds of 2,4-D especially when an ester was used. About 1 pound per acre is required to kill cocklebur, in stages of growth up to maturity. It was also noted that .25 to .5 pounds, to a large extent, reduced seed production of cocklebur and ragweed (both species) when applied in the blossom stage of growth. (*Extension Botanist, Purdue University, Lafayette, Indiana.)

The relative susceptibility to 2,4-D of four annual weeds at different stages of growth. Timmons, F. L.* Duplicated spray applications of the isopropyl ester and the triethanolamine salt of 2,4-D were made at rates of .5, 1.0, and 1.5 pounds per acre (acid basis) on Russian thistle (Salsola kali var. tenuifolia), lambsquarters (Chenopodium album), rough pigweed (Amaranthus retroflexus), and sunflower (Helianthus annuus) at 3 to 6 different stages of growth from emergence to bloom or early seed. The .5 pound rate was omitted in the last applications on all four weeds and the 1.5 pounds-per-acre rate was omitted in the first two applications on Russian thistle and lambsquarters. The ester was much more effective on all four weeds than the amine salt at equivalent rates and gave better kills of Russian thistle and lambsquarters at .5 pounds per acre than the amine salt at 1.0 or 1.5 pounds per acre. Russian thistle showed increasing resistance to 2,4-D after the seedling stage and was not effectively controlled after the early growth stage. Rough pigweed was effectively controlled by the ester at 1.0 pound per acre in all stages except early seed and was partially controlled by the amine at 1.5 pounds per acre. Lambsquarters was highly susceptible to the ester at all rates before the early seed stage and was controlled fairly well by the amine at the heavier rates before the bloom stage. Sunflower was highly sus-

ceptible to both types of 2,4-D formulations at bloom and earlier stages. (*Agronomist, Bureau of Plant Industry, Soils and Agricultural Engineering, USDA, cooperating with the Fort Hays Branch of the Kansas Agricultural Experiment Station.)

The relative susceptibility to 2,4-D of four winter annual weeds at different stages of growth. Timmons, F. L.* Duplicated spray applications of the isopropyl ester and the triethanolamine salt of 2,4-D were made at rates of .5 and 1.0 pound of 2,4-D acid equivalent per acre on treacle mustard (Erysimum repandum) and tansy mustard (Descurainia intermedia) at early bloom, full bloom, and early seed stages of growth, and on Canada fleabane (Erigeron canadensis) and western wild lettuce (Lactuca ludoviciana) at six different times from the rosette to bud or blossom stage of growth. Both chemicals were applied also at 1.5 pounds of 2,4-D per acre on all weeds at late stages of growth. The ester was much more effective on all four weeds than the amine salt at equivalent rates. The ester at .5 pound of 2,4-D per acre was as effective as the amine salt at 1.0 or 1.5 pounds of 2,4-D per acre. All four weeds showed increasing resistance to 2,4-D as they became more mature. The ester at .5 pound and the amine salt at 1.0 pound per acre (acid basis) gave satisfactory control of all four weeds in early stages of growth and of the mustards in early bloom. Both chemicals were relatively ineffective on the mustards or wild lettuce in the early seed stage or on Canada fleabane after the shooting stage even when they were applied at rates up to three pounds per acre. Results indicated that for effective and economical control with 2,4-D Canada fleabane must be sprayed while the plant is in the rosette stage. (*Agronomist, Bureau of Plant Industry, Soils and Agricultural Engineering, USDA, cooperating with the Fort Hays Branch of the Kansas Agricultural Experiment Station.)

Killing Purslane (Portulaca oleracea) with 2,4-D. Ure, C. R. During 1946-47, 33 plots densely infested with purslane were sprayed with three formulations -- sodium salt, ester, and amine salt -- at concentrations 1/2 to 2 pounds acid per acre, at various stages of growth. Although not the easiest of annuals to eradicate with 2,4-D, purslane was almost completely killed with the ester and amine salt formulations at concentrations of one-half pound upward in the pre-bud and bud stages. In the flowering stage it showed marked resistance; the butyl ester at two pounds gave a 75 percent reduction in stand. Except at a concentration of 2 pounds acid in the pre-bud and bud stage when 80 to 85 percent reduction in stand was obtained, sodium salt was quite ineffective. (Contributed by Dominion Experimental Station, Morden, Manitoba.)

Killing stinkweed (Thlaspi arvense) with 2,4-D. Wood, H. E. and Fraser, G. R. During 1945-47, in addition to 33 plots sprayed, observations were made on many other field plots and grain fields treated commercially. This weed was readily killed either as a winter survivor or in the spring emerged form, at all stages to a point where seed formation commenced, thereafter, it became quite resistant. As a winter annual sprayed in early spring in flower at 4 ounces acid per acre concentration, sodium salt gave 50 percent kill, ester 100 percent kill. On spring growth in pre-bud, 4 ounces gave for sodium salt 88 percent kill; amine salt 92 percent kill; 1 pound gave 100 percent kill all formulations. (Contributed by Weeds Commission, Manitoba Department of Agriculture.)

Killing cocklebur (Xanthium orientals) with 2,4-D. Wood, H. E. and Fraser, G. R. On limited trials (4 plots) during 1946, this weed was very readily killed with all formulations at .1 percent concentration. To test company products, a very low concentration (2 oz. acid per acre) was applied to dense stands of this weed, July 16, 1947, when the plants were in the prebud stage (3 to 6 inches high); kills ranged from a low of 45 percent to 95 percent. (Contributed by The Weeds Commission, Manitoba Department of Agriculture.)

Killing false ragweed or marsh elder (Iva zanthifolia) with 2,4-D. Wood, H. E. and Fraser, G. R. On 25 plots treated 1945-47, with all formulations, with concentrations 8 to 16 ounces acid per acre, this weed in the active growing stage has been very readily killed. However, as the plant approaches the seed setting stage it becomes quite resistant. (Contributed by The Weeds Commission, Manitoba Department of Agriculture.)

EXPERIMENT V

EFFECT OF 2,4-D ON CEREALS, FLAX, GRASSES, CORN, AND OTHER TOLERANT CROPS

REGIONAL SUMMARY

Glen Viehmeyer 1/

When 2,4-D became available to those engaged in weed control research, the first efforts were to determine the chemical's toxicity to undesirable plant life and little attention was paid to its effect on the crop plant in which the weed was growing. This trend continued through the 1946 season but many investigators were becoming concerned at the injurious effects on treated crops. At the North Central Weed Control Conference held in Des Moines, Iowa, December 11-13, 1946, the necessity of more information on 2,4-D effects on crop plants was recognized and the Research Committee wrote Uniform Experiments V and V-2 for inclusion in the 1947 research program.

From the abstracts and reports received on Experiment V, it is quite evident that the dosages that have been generally recommended and used for the control of annual weeds in crop plants are too high for safety and that a revision of those dosages downward must be made if the maximum and most economical use of the herbicide is made. It is fortunate that such revision of dosages is possible. Reports from many sources indicate that much lower dosages will effectively control most of the serious annual weeds and this being the case, it would seem that such revision of recommended dosages is mandatory.

The case of the noxious perennial weeds with their extensive underground root systems is somewhat different. Here it becomes increasingly apparent that the minimum effective treatment for the weed kill, in most cases, cause injury to the crop plant and control measures become a matter of treatment before crop is planted, after it is harvested or, as in the case of corn and the small

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grains, after it has developed to the point of maturity where the herbicide can no longer seriously affect yields.

A study of the abstracts indicates clearly the necessity of the revision of the recommended dosages for the control of annual weeds in crops and a clarification of the time of safe treatment in the case of noxious perennial weeds where the higher dosages are a necessity. The Research and Policy Committees must recognize that the use of 2,4-D in growing crops is no longer an experimental thing and that it is being used upon thousands of acres of growing crops in the Region. Excessive dosages can and will mean extensive losses in crop yields and for the purchase and application of unneeded chemicals.

Spraying corn with 2,4-D. Bakke, A. L. June 28, 1947 - Early stage - Crystal Lake, Iowa - 1 qt. Weed-No-More per 100 gallons per acre. One spraying - one cultivation - 730 lbs., 1/4 acre plot. Not sprayed - 2 cultivations - 725 pounds, 1/4 acre plot. June 19 - Early stage - Kanawha, Iowa.

100 stalks - Weed-No-More 1/4 pt. per acre - 2nd & 4th cultivations - 45.5#
100 stalks - " " " 1/2 pt. " " " " " - 42.0#
100 stalks - not sprayed - - - - - - - - - - - 4 cultivations - - - - - 42.0#
(Contributed by Iowa Agricultural Experiment Station.)

Some effects of 2,4-D sprays on the yields and growth of barley and oats. Buchholtz, K. P.* Experiments were conducted in 1946 and 1947 to determine the effect of several 2,4-D top sprays on the yielding ability, seed germinations, kernel weight and lodging resistance of Oderbrucker barley and Vicland oats. Both sodium salt and butyl ester preparations of 2,4-D were used and were applied at the 4, 8 and 14 inch growth stages of the grain. In 1946, rates of 1, 2, and 4 pounds per acre of the 2,4-D acid equivalent were applied but in 1947 they were reduced to 0.5, 1, and 2 pounds per acre. The experimental area was essentially weed free. The various sprays failed to affect the yield of barley significantly in either 1946 or 1947. Germination of seed from the treated plots was fully as good as from the untreated plots. Kernel weight of the barley was increased significantly by treatment at the 4 and 8 inch growth stages. Lodging was reduced significantly in several instances by the 2,4-D treatments. The higher rates of application and applications at the 4 and 8 inch growth stage were particularly depressing and resulted in yields but from 60 to 80 percent of check. Germination was reduced significantly by 7 of the 18 treatments and particularly by the heavier rates at the 4 and 8 inch growth stages. Neither kernel weight nor lodging reaction was influenced materially by the different treatments. The sodium salt of 2,4-D was significantly less toxic than the butyl ester to the oat plants in both 1946 and 1947. (*Department of Agronomy, University of Wisconsin.)

Effect of several herbicidal preparations on the growth and yield of corn. Buchholtz, K. P.* A corn single hybrid, R3 x M13, was planted in replicated 20 hill plots and top sprayed with the butyl ester and with the sodium, ammonium, and amine salts of 2,4-D at the rate of 1 pound of the acid equivalent per acre when the corn was 20 inches high. Of the dinitro materials such as Dow Selective and Sinox, the former was applied at the rate of 3 pints to the acre and the latter at 1/2 gallon per acre with 1 1/2 pounds of activator. All of the 2,4-D preparations caused marked proliferation of the brace roots and caused the corn stalks to bend. A number of the stalks were broken off soon after treatment by wind and cultivation. Nearly equal brace root injury appeared to be caused by

the different preparations. Plots treated with sodium salt had 62 percent bent plants while those treated with the other preparations had approximately 75 percent. Plant breakage varied from 12 to 34 percent, being lowest with the sodium salt and highest with the butyl ester. The Dow Selective burned the corn leaves severely while the plants treated with Sinox were nearly unaffected. The grain yields varied from 52 to 70 percent of check, being 39.3, 43.0, 47.2, and 52.8 bushels per acre respectively, for the plots treated with the butyl ester, amine, ammonium, and sodium salt preparations of 2,4-D. All of these yields are significantly less than check. The grain yields from the dinitro treated plots were not significantly less than check, being 94 and 100 percent of the check for the Dow Selective and Sinox treatments respectively. (*Department of Agronomy, University of Wisconsin.)

Effect of date and rate of 2,4-D application on the growth and yield of corn. Buchholtz, K. P.* Two single hybrids, R3 x M13 and 153 x 25, were planted in replicated 20 hill plots. Plots were sprayed at the 10, 20, and 40 inch growth stages with 0.5, 1.0, and 2.0 pounds of 2,4-D acid equivalent as the sodium salt. The 10 and 20 inch applications were over all top sprays. The 40 inch application was applied from the side to the lower 30 inches of the plants. Corn brace root proliferation was especially severe following the applications at the 20 inch growth stage. There was only a slight amount of proliferation on plots treated at the 10 inch stage and none on those treated when the corn was 40 inches high. The heavier treatments produced a bending of 50 percent of the stalks following treatment at the 10 inch stage. At the 20 inch stage bending was even more severe with percentages of as much as 70 percent. No bending was noted after the 40 inch application. Loss of plants due to stalk breakage was greatest on the heavier application made at the 20 inch stage. Proliferation of roots and degree of stalk bending and breakage was distinctly greater for the R3 and M13 hybrid than for 153 x 25. Grain yields were reduced significantly by all treatments made at the 20 inch stage and by the heavier treatments made at the 10 inch stage. Reductions of as much as 36 percent were recorded. None of the treatments at the 40 inch growth stage reduced yields significantly. (*Department of Agronomy, University of Wisconsin.)

Effects of 2,4-D sprays on growth and yields of several corn hybrids. Buchholtz, K. P.* Wisconsin yellow dent double hybrids W355, W464, W606, W641A, W692, single hybrid R3 x M13 and Golden Cross Bantam sweet corn were grown in replicated 20 hill plots. When 20 inches tall they were sprayed with the sodium salt of 2,4-D at the rate of 1 pound of the acid equivalent per acre. The area was cultivated 3 times and hoed twice to prevent interactions due to weed growth. The 2,4-D spray caused proliferation of the dent corn brace roots, bending of the stalks and some stalk breakage from wind and cultivation. The Golden Cross Bantam sweet corn appeared to be nearly unaffected in any of these respects by the 2,4-D spray. The earlier hybrids, W355, W464, W526, and R3 x M13 in particular showed considerable root proliferation. Stalks bent varied from 33 to 10 percent with hybrids W641A and W692 being definitely less susceptible. Stalk breakage was not great in this experiment but 10 percent of the plants of hybrids W464 and W692 were lost in this manner. Grain yields varied from 83 to 104 percent of the untreated check plots. The yields of the treated plots in percent of the checks were 83, 85, 91, 91, 84, 86, and 104 percent respectively for the hybrids W355, W464, W525, W606, W641A, R3 x M13 and Golden Cross Bantam. The yields of all of the dent corn varieties was reduced significantly by the 2,4-D treatment. The yields of the earlier hybrids appeared to be

reduced the most. The yield of Golden Cross Bantam sweet corn was apparently unaffected by the 2,4-D treatment. (*Department of Agronomy, University of Wisconsin.)

Effect of herbicidal sprays on the stands of clover and alfalfa. Buchholtz, K. P.* Nine herbicidal sprays were applied to oat plots intersown with clover and alfalfa. Sprays were applied when the grain was about 15-18 inches high. Legume counts were made after the grain had been harvested. All 2,4-D preparations were applied at the rate of 1 pound per acre of the acid equivalent. Of the dinitro materials such as Sinox W and Dow Selective, the former was applied at the rate of 8 pts. per acre, and the latter at 4 pts. per acre. Sinox was applied at the rate of 1 gal. per acre with 1 1/2 pounds of ammonium sulfate as activator. Clover stands on plots treated with the ethyl, butyl and isopropyl esters of 2,4-D were 25, 47, and 29 percent of check respectively. Alfalfa stand on these same plots were 2, 0, and 2 percent of check. The plots treated with sodium ammonium and amine salts of 2,4-D had clover stands 99, 102, and 92 percent of check and alfalfa stands were 26, 35, and 17 percent respectively. Differences between different salts and esters were not usually significant but differences between the ester averages and the salt average were highly significant. Dinitro sprays were relatively more toxic to clover than to alfalfa. Clover stands of 86, 80 and 59 percent were obtained for the Sinox W, Dow Selective and Sinox treatments. Alfalfa stands for these same treatments were 84, 110 and 117 percent respectively. (*Department of Agronomy, University of Wisconsin.)

Effect of date and rate of applying 2,4-D sprays on legume seedling stands. Buchholtz, K. P.* In the spring of 1947 oat plots were intersown with 6 pounds each of alfalfa and red clover. The plots were sprayed with a sodium salt and a butyl ester 2,4-D preparation at the rate of 0.5, 1.0 and 2.0 pounds per acre of the acid equivalent when the grain was 4, 8 and 14 inches high. Legume counts were made after grain harvest in the fall. All treatments caused reductions in the stands of clover and alfalfa. Clover stands on plots treated with the ester were about half of those on the sodium salt treated plot. Date of application affected the clover stand obtained being 43, 31 and 78 percent of check for the 3, 8, and 14 inch application date. Clover stands 90 percent of check were obtained by making applications of 0.5 pound of the sodium salt at the 14 inch stage. Alfalfa was considerable more sensitive to 2,4-D than was clover. The ester preparation injured the stand more than did the sodium salt. The average alfalfa stands obtained from sodium salt treatments made at the 4, 8 and 14 inch stage were 43, 14 and 56 percent respectively. Approximately 60 percent of check stands were obtained by using 0.5 pound of the sodium salt at the 14 inch stage. The data suggest that the increased shielding afforded by the larger grain at the 14 inch stage and possible a reduced suspectibility of the legumes to 2,4-D when grown in the partial shade of the larger grain favor the retention of legume stands in grain fields treated with 2,4-D sprays. (*Department of Agronomy, University of Wisconsin.)

Experiment V - Effect of 2,4-D sprays on corn. Buckley, G. F. H.* In this experiment, three forms of 2,4-D, Viz., sodium salt, amine and methyl ester, were used at the rates of 0.5, 1.0, and 1.5 pounds of 2,4-D acid per acre. The spray was applied to the corn hybrid Canada 645 on June 25th, when the plants were six inches high and in the five leaf stage, using one gallon of spray per square rod. Based upon the limited data that is available, the results would indicate the following:

1. Only with the heaviest application of methyl ester (1.5 pounds) was there any great reduction in stand.
2. There was some recovery from injury, the greatest being in the plots receiving the lowest rate of 2,4-D.
3. In all cases the degree of injury increased with heavier rates of application. Of the three forms of 2,4-D the methyl ester was the most severe.
4. Many plants in the methyl ester plots showed a rolling of the leaves tightly encasing the tassel.
5. By the end of July, the plants showed a high degree of recovery but those in the methyl ester plots were still about a foot shorter than those in the other plots.
6. No yield data can be supplied at this time.

(*Sr. Assistant, Forage Crops, Dominion Experimental Station, Harrow, Ontario.)

Effect of 2,4-D spray on spring planted Kanota oats. Elder, W. C.* Three types of 2,4-D were applied on Kanota spring oats when 3 to 4 inches high and again just before the heading stage. 1/2 lb., 1 lb., 1 1/2 lbs., and 2 lbs., per acre was applied at the rate of 1 1/2 gal. per sq. rod. The 1 1/2 lbs. and 2 lbs. per acre applications lowered yields more on the 3 to 4 inch oats than applications made just before heading. The 1/2 lb. and 1 lb. per acre plots gave yields very similar for both dates of application. All 1/2 lb. per acre plot yields were 10 to 15 percent lower than check plots. The 2 lbs. application gave a decreased average yield of 25 to 30 percent. The ester type gave lower yields than the salt and amine types when the 1 1/2 lbs. and 2 lbs. per acre applications were used. (*Assistant Agronomist, Oklahoma A & M College.)

Experiment V. Effect of 2,4-D sprays on wheat. Elder, W. C.* An ester type and a salt type of 2,4-D were applied at the rate of 1 1/2 gal. per sq. rod each of 1/2 lb., 1 lb., 1 1/2 lb., and 2 lbs. per acre on Pawnee wheat just at the start of the jointing stage. The same procedure was used on the wheat at the start of the heading stage. The last application was made at the time considered best for 2,4-D applications on bindweeds in spring. Only slightly higher yields were harvested on tests made at the start of the jointing stage compared with treatments made at the start of the heading stage. There was no difference in yields from the acid type and ester type of 2,4-D applications. The 1/2 lb. per acre applications gave a slight decrease in yield compared with check plots. The 2 lbs. per acre applications gave a 15 percent decrease in yields. An application of 2,4-D was made on wheat in the fall months at stooling stage. It appears that this early application is more severe on wheat yields than spring applications. Fall applications produced poor stools and delayed maturity. (*Assistant Agronomist, Oklahoma A & M College.)

Effect of 2,4-D sprays on sorghums, 1947. Elder, W. C. * Two grain sorghums and two forage sorghums were planted and cultivated. Weeds were removed with a hoe. When the plants were 1 ft. high the sorghums were sprayed at the rate of 1 1/2 gal. per sq. rod of 1/2 lb., 1 lb., and 2 lbs. per acre each of an ester and a salt type of 2,4-D. Ovendry weights were taken for the forage sorghums and threshed grain weights were taken for the grain sorghums. Results were very similar for the forage and grain sorghums and there was not a noticeable difference among varieties. Two lbs. per acre applications of 2,4-D definitely lowered yields in all plots. The plants in these plots lodged badly. In many instances the brace roots were abnormal and did not penetrate the soil.

The 1 lb. applications per acre gave results just a little below the check plots. The ester type gave slightly lower yields than the salt for the 1 lb. and 2 lbs. per acre applications. The 1/2 lb. applications gave an increased yield over check plots. More tests will be necessary to see if the light application acts as a stimulant to sorghum production. (*Assistant Agronomist, Oklahoma A & M College.)

Effect of 2,4-D sprays on mungbeans. Elder, W. C.* Salt and ester types of 2,4-D were applied on mungbeans at the rate of 1/2 lb., 1 lb. and 2 lbs. per acre. Applications were made when the beans were 6 inches high and again just before blooming. Golden mungbeans, a forage bean, and Green mungbeans, a sprouting bean, were used in this test. Weeds were allowed to grow after planting. The ester type was much more severe than the salt type on mungbeans, however more weeds were killed by the ester and the final yields of beans were about the same for both types. The 2 lb. application arrested all growth for some time but did not kill the beans. The injured plants recovered and made fair yields. The growth of the beans was affected in the 1/2 lb. per acre plots but they soon recovered and made good yields of forage and seed. It was difficult to compare yields of the treated plots with untreated plots because they did not mature at the same time. 2,4-D treatments had about the same effect on the two kinds of beans. While mungbeans are somewhat susceptible to 2,4-D it is possible to use up to 1 lb. per acre and still get fair forage and seed yields. (*Assistant Agronomist, Oklahoma A & M College.)

Effect of 2,4-D sprays on cereals, flax, wheat, oats, and barley. Ficht, J. P. All crops were sprayed with Chipman's (Sodium salt 60 percent) Naugatuk (Amine 30 percent) and Weed-No-More (Ester 32 percent) at 1/4 and 1/2 pound per acre. Wheat (Rescue) sprayed when three inches high developed deformed heads and a noticeably uneven stand at both rates with all chemicals. Date of heading and maturity delayed 3 to 6 days. Wheat sprayed just before emergence and after plants were five inches high did not develop deformed heads. There was no significant delay in maturity. Oats (Ajax) and barley (Titan) sprayed at height of three inches showed a noticeable uneveness of stand with heading and maturity delayed three to six days. Flax (Royal) sprayed at early four-leaf stage showed severe reduction of stand from Naugatuk at one-half pound, and Weed-No-More at one-quarter and one-half pound per acre. Flax sprayed in bud stage with one-half pound Naugatuk branched more profusely and filled with seed, but was retarded about two weeks in maturing. Similar results were observed on a farm where flax was sprayed when about four inches high. (Contributed by Dominion Experimental Station, Swift Current, Saskatchewan, Canada.)

Effect of three types of 2,4-D formulations at three dosage levels on morphology and yield of corn as well as weed control. Hanson, Noel S.* This experiment was conducted to study tolerance of corn to 2,4-D applied for control of both annual and perennial weeds. Three types of 2,4-D were applied at dosages of 1/2, 1, and 1 1/2 pounds acid equivalent in 40 gallons of water per acre. Application was at the laying-by stage of corn and to bindweed, pigweed, buffalo bur, wild ground cherry, foxtail, and stinkgrass in the vegetative, rapid-growth stage. Application was with tractor-mounted equipment over the top of the corn. Observations two days after treatment indicated considerable brittleness of the treated corn and some curvature of plants with typical curvature of weeds in inverse proportion to dosage. Later observations showed several broken plants in plots treated with 1.0 and

1 1/2 pounds butyl ester per acre. Considerable distortion of plants expressed through enlarged and cracked stalks, distorted brace root, and bending at the lower nodes was noted from all treatments with most intense effects from the butyl ester and least from sodium salt in inverse proportion to damage. Ear formation was slightly reduced from all treatments but average ear weight was greater on all 1/2 pound plots than on the untreated. Root volumes on the average of 25 roots, were reduced below the untreated on all 1/2 pound plots but were greater from the 1 pound and the 1 1/2 pound plots of amine salt and sodium salt. While differences in root volume existed and some roots showed considerable fiberous root increase from 2,4-D, this phenomenon was not consistent. Yield was equal to and slightly above the untreated cultivated 3 times from the 1/2 pound treatments, but considerably reduced at the 1.0 and 1 1/2 pound levels. All yields were above the untreated cultivated twice. Bindweed control was nearly as effective at the lower dosages as at the higher. (*Assistant Agronomist, Nebraska Experiment Station, Lincoln.)

Effect of five types of 2,4-D formulations at four dosage levels on plant tolerance and yield of Dunfield soybeans. Hanson, Noel S. and Wolfe, Henry* This experiment was conducted to determine maximum tolerance to 2,4-D of soybeans and differential tolerance of the various type formulations. The type formulations sodium salt, amine salt, butyl ester, isopropyl ester, and ethyl ester were applied to Dunfield soybeans at dosages of 1/8, 1/4, 1/2, and 1 pound acid equivalent per acre when the plants were in the vegetative pre-bud stage. Observation 24 hours after treatment showed intense curvature and lodging of the soybean plants. Later recovery was in inverse proportion to dosage and varied by formulation. Final observations and yield determination were made October 15 to 20, 1947. Final results on percentage kill of plants showed no kill from either formulation at the 1/8 pound level and no kill from the sodium and amine salt at either the 1/4 or 1/2 pound levels. At the one pound level these two formulations caused 16 and 23 percent kill of plants, respectively. The three esters caused kills varying from 8 to 14 percent at 1/4 pound, 35 to 91 percent at 1/2 pound, and 61 to 91 percent at the one pound levels. The most severe kills resulted from the butyl ester and the least from the ethyl ester of the three esters. The sodium salt was slightly less severe than the amine salt. Yields were in inverse proportion to dosages in all cases varying from nearly equal to the check plots at 1/8 pound to nearly complete destruction of the crop by the butyl and isopropyl esters at the one pound level. (*Assistant Agronomist and Graduate Assistant, Nebraska Experiment Station, Lincoln, respectively.)

Varietal differences in crop tolerance to 2,4-D. Kusch, A. G.* Four rates of butyl ester, viz: 1/4; 1/2; 1 and 2 pounds per acre were used when the grain was about 4 inches high. No varietal differences were apparent on any of the four crops for the two lowest rates. However, the 1 pound and especially the two pound rate gave rise to some observable differences between varieties of the same crop. In wheat, Rescue was affected the most, Apex somewhat less while Thatcher and Redman did not appear to be affected. The latter three varieties reacted with larger kernels and higher bushel weights. Rescue was adversely affected in this respect. In oats, Exeter was most affected. Victory next, then Garry, with Ajax appearing to receive a stimulus. In all varieties kernels and bushel weights were increased. In barley, Titan and Velvon were both adversely affected with Vantage and Plush showing only slight damage. In all cases, kernel and bushel weights were increased. (*Cerealist, Dominion Experimental Station, Scott, Sask.)

Result of uniform experiment V. Effect of 2,4-D sprays on corn. Lee, Oliver C. Applications of 0.25, 0.5, 1.0 and 1.5 pounds of 2,4-D (Sodium salt) per acre in 120 gallons of water was applied to corn 10 to 12 inches in height. The average yield on check plots was 69.8 bushels per acre, compared to 69.2, 70.6, 66.9, and 65.5 on plots sprayed at the rate of 0.25, 0.5, 1.0 and 1.5 pounds per acre respectively. Amounts up to 1 pound per acre did not materially affect yields while 1.5 pounds of 2,4-D reduced the yield over check plots 4.3 bushels. One pound of 2,4-D (Sodium salt) per acre was applied as a spray to corn 6, 12, 20 and 30 inches in height. Yields were -5.8 bushels on plots sprayed when corn was at a height of 6 inches, plus 1.3 bushels on 12 inch corn, -5.8 bushels on 20 inches corn, and -2.7 bushels when corn was sprayed at a height of 30 inches compared to check. Average yield for check plots was 85.2 bushels per acre. Other experiments have shown that damage to large corn can be reduced by applying sprays with a row crop sprayer in such a manner as to allow a minimum amount of spray to come in contact with the top of the corn plant. While no difference was noted between side or over the top applications on small corn. (Contributed by Agricultural Experiment Station, Purdue University, Lafayette, Indiana.)

The effect on the yield of wheat, oats, barley and flax sprayed with three formulations of 2,4-D, five concentrations and at three stages of growth. Leggett, H. W. WHEAT: All wheat plots treated in the 3 leaf stages produced distorted heads i.e. clubbing, twin heads, etc. This distortion was totally absent from the two stages following. In the two latter stages, treated with 3, 4, and 5 pounds of acid in all formulations but more noticeable in the amine and ester formulations, the percent of sterile florets ranged from 15 to 60 percent as the concentration increased. The over-all picture seems to be that except for distorted heads produced by early spraying, less damage results from early spraying than late spraying. BARLEY: (Sanalta) Distorted heads while much more general in the 3 leaf stage spraying also were found in the plots sprayed at other stages. Sterile florets were in the same range and stages as those of the wheat sprayed in the last two stages. It is interesting to note that both in barley and wheat there were very few sterile florets observed from spraying in the 3 leaf stage. After spraying the barley plots, without exception, appeared to be badly damaged as though hit by 5° of frost but they came back extremely well and all matured within six days of the check plot. OATS: (Larain) The oat plots appeared to be the least resistant cereal to 2,4-D treatment. Plots sprayed in the 3 leaf stage showed the least damage and of these plots no distorted heads were observed. The roots of the oat plants showed distinct damage while those of wheat and barley plants showed damage only on plots treated with four and five pounds of the acid. The percentage of sterile florets increased with formulation, concentration and stage respectively. Ranging throughout the 46 plots from 2 percent in the check plot to 70 percent in the five pound butyl ester plot sprayed in the pre-heading stage. FLAX: (Redwing) The flax plots showed a very definite cut-off line as regards concentrations of the various formulations. All of the 5 pound concentration plots were completely wiped out and the other produced no seed. The one point that stood out in the flax plots was date of maturity. Compared with the check plot the maturity of the Sodium salt plots were delayed 3, 5 and 7 days, as the concentration increased; Amine plots were delayed 5 and 7 days; and butyl ester plots were delayed 6 and 9 days. There was no difference in regard to stage of growth when treated. (Contributed by Dominion Experiment Station, Lacombe, Alberta.)

Effects of 2,4-D on cereals and flax. Olson, P. J. and Zalik, Saul. Two formulations, ester (butyl) and sodium salt were applied to each of four crops, namely Redman wheat, Garry oats, Montcalm barley and flax. The application was made at three rates: 1/2 lb., 1 lb., and 2 lbs., per acre (pure acid equivalent) in the case of wheat, oats and barley, and 1/4 lb., 1/2 lb., and 1 lbs., in the case of flax. The applications were made on each of two dates, when the plants were respectively approximately 8 to 10 inches tall, and when they were just beginning to head (cereals) and bloom (flax). The ester produced much more damage than the sodium salt in all cases. The sodium salt actually produced no damage that could be measured by statistically significant differences in yield between treatments. In the case of ester the least damage was done to wheat. The 1/2 lb. rate did no damage to wheat or oats. The damage from the 2 lb. rate was severe in all cases. The 1/4 lb. rate did relatively little damage to flax, but the damage from the 1/2 and 1 lb. rate was severe. The later application of ester did not produce significantly greater damage than the earlier one except in the case of barley. Here the effect of treatment at the second date was much more severe. Highly significant reductions in yield took place at all three dates. The reduction at the 1 and 2 lb. rates was more than 40 and 50 percent respectively. (Contributed by Division of Plant Science, The University of Manitoba.)

The effect of different types of 2,4-D formulations at various rates of application on winter wheat at two stages of growth. Timmons, F. L.* Duplicated spray applications were made October 20, 1946, on weed-free Comanche winter wheat in the tillering stage, comparing the sodium and triethanolamine salts of 2,4-D at 2, 3, and 4 pounds per acre (acid basis) and the butyl ester of 2,4-D at 1, 2, and 3 pounds per acre (.8, 1.6, and 2.4 lbs. of 2,4-D.) Duplicated spray applications were made April 7, 1947, on an adjacent area in the same field comparing the same 2,4-D formulations at .5, 1.0, 1.5, and 2.0 pounds per acre (acid basis). The wheat was six inches tall and beginning to joint. No weeds were present. The rates tested in the fall applications are those that would normally be used in spraying perennial weeds in growing wheat while those tested in the spring treatments are comparable with rates used in selective spraying of annual weeds in small grain. All fall treatments reduced tillering, delayed maturity, and caused poor exertion of wheat heads. Yields were reduced 23, 39, and 51 percent respectively, by the amine salt, sodium salt, and butyl ester at 2 pounds per acre and 40, 55, and 50 percent, respectively, by the same chemicals at 3 pounds per acre. The spray applications made April 7, 1947, retarded growth of wheat only temporarily, the effect being most noticeable on plots sprayed with the butyl ester. Wheat yields on spring treated plots were variable due to differential lodging, but there were no consistent trends in the yield data and no significant reductions or increases in yield due to 2,4-D treatment. (*Agronomist, Bureau of Plant Industry, Soils and Agricultural Engineering, USDA, cooperating with the Fort Hays Branch of the Kansas Agricultural Experiment Station.)

Treating corn with 2,4-D - post emergence. Willard, C. J. Preliminary tests in 1945, 96 plots in 1946, and 28 plots in 1947 were devoted to a study of the effect of 2,4-D as a direct application to corn. The 1946 applications were of solutions made up at 0.1 percent and 0.2 percent, applied directly to the corn. Since the corn occupied only a small area of the field, it is difficult to state this in terms of pounds per acre. The corn plants were thoroughly wet. It would certainly be equivalent to at least 2 and 4 pounds per acre respectively. The sodium salt, triethanolamine and three esters were ap-

plied at eight different dates beginning when the corn averaged 10 inches high and ending two weeks after tasseling, or about the milk stage. In 1947, the butyl ester was applied at several rates when the corn was 30 to 20 inches tall. All treatments of two pounds per acre or more before the tasseling stage obviously damaged the corn and significantly reduced the yield. The reduction in yield ranged from a third to a half, mostly around a third. In 1947 one pound per acre did perceptible damage but the corn outgrew it and the yield was not significantly reduced. We would conclude that any direct application to corn should not be heavier than one pound of 2,4-D acid per acre, and preferably less. In both 1945 and 1946, 2,4-D sprays applied to weeds on the ground, hitting just the bases of the corn stalks, usually did not reduce the yield at all. Where the yield was apparently reduced the loss was not statistically significant and very much less than that from the same amount of spray applied to the corn. (Contributed by Ohio Agricultural Experiment Station in cooperation with the Dow Chemical Company and Sherwin-Williams Company.)

Effect of 2,4-D on winter wheat. Willard, C. J. Winter wheat was treated with 2,4-D in 1946 and 1947. In 1946 a standard rate of 4 pounds per acre of 2,4-D acid was used. In 1947 rates from 1/2 pound to 2 pounds per acre were used. Yields of wheat were obtained from square yard samples in each year but the non-uniformity of the land in 1947 made the yield results totally non-significant. In 1946 there was no apparent damage or loss in yield from treatment April 5th in the rosette stage. Treatments May 8th at the shooting stage cut the yield from nearly a half to two-thirds, the action of the esters being much more severe. A similar but slightly less loss occurred on May 22 when treated when the heads were appearing. There was some injury and loss in yield even when treated at the end of bloom on June 6th. Treating on June 20 had no effect on yield. In 1947 the ester caused significant reduction in yield on May 27 at all rates greater than 1/2 pound acid equivalent per acre. This was obvious from the appearance of the plots of the field. Apparently winter wheat will stand rather moderate rates of treatment without material injury in the rosette stage in the early spring but at later stages injury is likely if the rate of application exceeds 1/2 pound acid equivalent per acre. After the milk stage there is no apparent injury to the crop. (Contributed by Ohio Agricultural Experiment Station in cooperation with Dow Chemical Company.)

CHEMICAL WEED CONTROL IN HORTICULTURAL CROPS

REGIONAL SUMMARY

Glenn Viehmeyer 1/

The advisability of adding a section dealing with the problem of weed control in horticultural crops was brought to the attention of President Noel S. Hanson, and he asked the author to take the responsibility of contacting cooperators and preparing a report on work being carried on in this particular field. This was done and as result the following abstracts were assembled and mimeographed under the above heading.

1/ Horticulturist, University of Nebraska Sub-station, North Platte, Nebraska

Abstracts in this grouping for the most part fall under Uniform Experiments V, V-2, and VI-2. It was intended to include only papers dealing with horticultural crops in Experiments V and V-2 in this section but a number of abstracts falling under Experiment VI-2 were received late and were for this reason included in this section. The earlier papers on effect of soil treatments on horticultural crops were sent to Dr. Dunham who is summarizing Experiment VI-2 and persons interested in that phase of the problem are referred to his report on Experiment VI-2.

Various hydrocarbons such as Stoddard's solvent, the HB Aromatics Varsol (3139) Kerosene and various Diesel fuels have been used with considerable success in the control of weeds in carrots, dill, parsnip, onion and both table and sugar beets. At the present time these products seem destined to have an important place in weed control in those and perhaps other crops.

A number of phenolic compounds appear to have some promise but their use has been too limited to determine their ultimate value as herbicides. At this time the place of 2,4-D in controlling weeds in most vegetable crops appears to be limited to pre-emergence treatments. A number during the growing season.

The least injury was reported on large seeded vegetables such as beans, sweet corn and some of the curcubits. This may mean that the seeds are planted deep enough to escape injury while germinating.

A number of investigators have reported the successful use of the herbicide on potatoes while others have noted severe injury. Injury was most apparent to plants sprayed shortly after emergence. No investigator reporting injury from pre-emergence treatments.

Weed control in asparagus beds before and during cutting appears to be possible and the growth habit of the plant would seem to make it possible to spray during the entire season if proper booms that do not apply the chemical directly to the plant are used.

Preliminary work with raspberries and strawberries seems to indicate that 2,4-D will play an important part in weed control in those crops, and work with both raspberries and strawberries shows a high degree of tolerance in most varieties. There is no reason to believe that the use of 2,4-D will become a standard practice in the production of these fruits.

The salts of 2,4-D have been used in weed control in orchards with no apparent injury to trees if reasonable care is taken to prevent direct application to the trees.

SOME NEWER DEVELOPMENTS IN WEED CONTROL AS APPLIED TO VEGETABLES

Benjamin Wolf 1/

Experiments with vegetables have indicated the possibility of effective

1/ The G.F.L. - Seabrook Farms Raw Products Research Division, Seabrook Farms, Bridgeton, New Jersey

weed control with chemicals. The chemicals used during the 1947 season along with their advantages and limitations are listed below:

1. Stoddard Solvents (a) The use of Stoddard solvents at rates of 80 - 160 gallons per acre as pre-emergence sprays for both beets and spinach was very effective as a herbicide when used at the right time. With this material, it is essential that weeds appear before the crop since only the weeds emerged or just emerging are killed. This is accomplished by preparing the seed bed some time before planting and allowing a large number of weeds to germinate. The crop is then planted with the least amount of disturbance to the soil. The spray is applied any time after planting but before any of the crop seedlings emerge. More effective control is obtained if the spray is applied shortly before emergence of the crop but is not always practical to do so. Applying the material in two applications, one-half immediately after planting and the remainder before the crop emerges seems to have some advantage.

One advantage of this material is that it soon volatalizes and leaves no harmful residue to affect the crops. Its primary disadvantage as compared to some other herbicides is in its cost which is relatively high. However, the cost will still compare favorably with hand weeding of such crops.

(b) The use of Stoddard solvents for selective weeding in carrots was practiced on over 200 acres. The material was applied in sprays at rates of 80-100 gallons per acre and in several areas two applications were used.

The sprays were applied rather late when some weeds were already six inches high or higher. Under such conditions, it was not possible to control the weeds with one application. In the future, it is planned to apply the spray as soon as the carrots have two true leaves. Getting at the weeds when they are younger insures better control with less volume.

2. 2,4-D Erratic results have been obtained with this material for both beets and spinach. Until further knowledge as to its behavior in soils is obtained, its use even in "pilot plant" stage will be limited to irrigated acreage. Where moisture was controlled, it has given good weed control at rates of 1-2 pounds of 2,4-D acid per acre as the sodium salt. The 2,4-D was applied in 100 gallons of water per acre to moist fitted soil prior to planting the crop. The soil was irrigated one week later and crop planted without further disturbance of the soil as soon as soil moisture was satisfactory.

The application of 2,4-D to dry soil is evidently not very satisfactory for weed kill is poor. The irrigation of soil before planting avoids injury from any 2,4-D which still may be active.

The use of 2,4-D is relatively cheap weed control. If used so as to avoid injurious effects, it will have a definite place.

3. HB. Aromatics This material from the petroleum industry has given good weed control when used as a pre-emergence spray for spinach. As in the case of Stoddard solvents, weeds were allowed to germinate before planting the crop. A 10 percent emulsion of HB Aromatics in water at rate of 100 gallons per acre gave fair control and at 200 gallons very good control. The spray was applied immediately after planting. The relatively low cost of this treatment warrants further study with it.

4. Di-nitro compounds The use of Dow Contact and Dow Selective sprays at rate of 1-2 gallons per 100 gallons of water per acre as pre-emergence treatments gave fair control of weeds in spinach. The control of broad leaf weeds was good whereas the control of grasses was poor.

The use of these materials for beets was unsatisfactory because of rather heavy injury of beets.

5. Cyanamid Fairly effective control of large weeds in first year asparagus was obtained with Aero-defoliant cyanamid at rates of 275-300 pounds per acre. This material promises much more effective control if used when weeds are only a few inches high. The advantage of supplying nitrogen along with weed killing should not be overlooked.

A PRELIMINARY STUDY ON THE VALUE OF VARIOUS CHEMICALS FOR THE CONTROL OF WEEDS IN ONIONS 1/

R. E. Nylund 2/

Experiment I

The following phenolic compounds were compared with 3 percent sulphuric acid to determine their possible value as selective weedicides for onions grown on a muck soil; A, sodium orthophenylphenate; B, sodium trichlorphenate; D, sodium 2, chloro-4-phenylphenate; F, 2, 3, 4, 6 tetrachlorphenol (sodium salt); G, sodium pentachlorophenate; H, sodium tetrachlorphenate (technical); and I, ammonium salt of dinitro-o-secondary butyl phenol (Dow G562). Each of the above materials with the exception of Dow G562 and 3 percent sulphuric acid were applied at the following concentrations: 1/4, 1/2, 3/4, 1, and 1 1/2 percent by weight. Dow G562 was applied at the rate of three pints to 100 gallons of water. The chemicals were sprayed on the onions and weeds at the time the onion plants had one true leaf using a three gallon knapsack sprayer fitted with a Monarch No. 59 weed nozzle.

The only treatments which were superior to three percent sulphuric acid as a weedicide for onions were A at 1 1/2 percent and B at 1 1/2 percent. The following treatments equalled 3 percent sulphuric acid in effectiveness: B at 3/4 and 1 percent, F at 1/2 percent, and G at 1/4 percent. All of the other treatments either were toxic to onions resulting in reduced stands and yields, or had no effect on weeds present.

Experiment II

In order to determine the possible value of some of the herbicides listed above when used at stronger concentrations on onions in the three leaf stage, another series of treatments were applied to onions seeded at the same time as those in Experiment I, but left unweeded until the onions had reached the three leaf stage. Weeds at this time ranged up to two feet in height. The following

1/Paper No. 606 of the Miscellaneous Journal Series, Minnesota Agricultural Experiment Station

2/University of Minnesota, St. Paul, Division of Horticulture.

treatments were used: A at 2 and 3 percent, B at 1 1/2 and 3 percent, D at 3 percent, F at 1 1/2, 2 and 3 percent, G at 1 and 1 1/2 percent, H at 1 1/2, 2, and 3 percent, and Dow G562 and 3 percent sulphuric acid at the same rate as in Experiment I. Of the above treatments only F at 1 1/2 percent and G at 1 1/2 percent and 3 percent sulphuric acid gave fairly good control of weeds without reduction in yields of onions.

The results obtained in Experiments I and II indicate that at least some of the compounds tested appear to have selective herbicidal properties. However, more detailed studies of their action on various weed species and on onions must be conducted before recommendations for their use in agricultural practice can be made.

ABSTRACTS

Oil: Pre-emergence with 26 vegetable crops. Alban, E. K. and Keirns, V. E. In June, during a period favorable for rapid weed germination, oil* at the rate of 100 gallons per acre was evenly applied to field plantings of carrot, asparagus, parsnip, dill, and radish approximately two days before crop emergence. No injury was noted on any crops, except a severe burning of a few radish seedlings that had emerged before treatment. All weeds above ground at the time of treatment were killed, and the area remained weed free for a two week period. Crops in the treated area grew far more vigorously throughout the balance of the season than did the same crops in the untreated area. In late July and early August, during a period non-favorable for rapid weed germination, the experiment was duplicated using 25 vegetable crops. Again, no injury was noted on any crop. However, the treatment did not materially reduce the stand of weeds growing in the fast-germinating crops, and was effective only if applied at least seven days after planting, on crops such as parsnip, parsley, potato and spinach. The important weeds present included crabgrass (Syntherisma sanguinale), pigweed (Amaranthus retroflexus), purslane (Portulaca oleracea), and foxtail (Chaetochloa viridis). (Contributed by Department of Horticulture, Ohio State University.) (*Stoddard Solvent, supplied by the Standard Oil Company of Ohio.)

Oil: Post-emergence with carrot, parsnip and dill. Alban, E. K. and Keirns, V. E. Oil* was applied at the rate of 50 gallons per acre on field plantings of carrot, parsnip, and dill. One series of plots were sprayed in the 3-4 leaf stage; a second series were sprayed in the 4-6 leaf stage; and a third series were sprayed approximately two weeks after the 4-6 leaf stage. No crop injury was noted from any treatment. At the time of the first series (3-4 leaf stage) most weeds were 4-8 inches tall, and the comparatively low gallonage (50 gallons per acre) was ineffective in controlling the weeds present. Some small weeds were killed, but the balance were merely checked in growth for a few days. The later treatments were even less effective as herbicides. One section of the first series was re-treated four additional times over a three week period. The third treatment finished killing all weeds present. Injury was not noted on any crops until after the fifth treatment, which caused some yellowing of parsnip leaves. Following the fifth treatment, an objectionable flavor was also present in carrots harvested at this time. The important weeds present included purslane, pigweed, crabgrass, and foxtail. (Contributed by Department of Horticulture, Ohio State University.) (*Stoddard Solvent, Supplied by the Standard Oil Company of Ohio.)

2,4-D: Post emergence with mung bean and potato. Alban, E. K. and Keirns, V. E. Concentration of .33, .66, and 1.32, and 1.98 pounds of the butyl ester of 2,4-D* per acre were applied to a field planting of mung beans. One series of plots were sprayed one week after emergence; a second series were sprayed three weeks after emergence; and a third series were sprayed five weeks after emergence. Concentrations of .33 and .66 pounds per acre were not effective herbicidal treatments for any appreciable length of time. The concentration of 1.32 pounds per acre, applied one week after emergence, controlled broad-leaved weeds and reduced the number and size of the grasses, with practically no injury to the crop. Later treatments with this concentration were not as effective. The concentration of 1.98 pounds per acre caused serious injury to the bean plants, but controlled all weeds present. Concentrations of .13 and .33 pounds of the butyl ester of 2,4-D per acre were applied to a field planting of potatoes at three weekly intervals, starting as the crop was emerging, on July 1. The treatments were effective in reducing the weed population, but serious injury was caused to the potatoes. The important weed species present included crabgrass, pigweed, purslane and foxtail. (Contributed by Department of Horticulture, Ohio Agricultural Experiment Station.) (*Agricultural Weed-No-More 40, supplied by the Sherwin-Williams Company)

2,4-D as a herbicide with asparagus. Alban, E. K. and Keirns, V. E. Concentrations of 1.32, 1.98, and 2.6 pounds of the butyl ester of 2,4-D 1/ were applied to an established planting of asparagus immediately following the first cutting, on May 20. All concentrations gave adequate control of all weeds present throughout the cutting season, a period of five weeks. However, the two higher concentrations were more effective than 1.32 pounds per acre in controlling the grasses. The same concentrations, applied to adjoining plots immediately following the fourth cutting of asparagus controlled the weeds, but the period required for killing was somewhat longer, due partially to the fact that the weeds were larger at the time of the latter treatments. The above treatments caused distortion of all asparagus spears that were above ground at the time of treatment, or approximately 50 percent of the first commercial cutting following treatment. No adverse effects were noted on subsequent cuttings. At the end of the cutting season, one plot not previously treated was disked. One week after disking the butyl ester of 2,4-D was applied at the rate of 1.32 pounds per acre, followed by an oil 2/ application of 50 gallons per acre. A special attempt was made to avoid contacting the growing tips of asparagus with the materials. This treatment controlled all weed species present, except Canada thistle, for a six week period. A few asparagus plants were slightly injured as a result of the treatment, but recovered in a few days. The important weed species present in the asparagus planting included Canada thistle (Cirsium arvense), pigweed, crabgrass, and foxtail. (Contributed by Department of Horticulture, Ohio Agricultural Experiment Station.)

2,4-D: Pre-emergence with 25 vegetable crops. Alban, E. K. and Keirns, V. E. Concentrations of .13, .33, .66, and 1.32 pounds of the butyl ester of 2,4-D* per acre were used as pre-emergence herbicidal treatments with field

1/ Agricultural Weed-No-More 40, supplied by the Sherwin-Williams Company.
2/ Stoddard Solvent, supplied by the Standard Oil Company of Ohio.

plantings of 25 vegetable crops. The three lower concentrations were applied immediately after planting, on July 21, while the concentration of 1.32 pounds per acre was applied approximately 24 hours later. The concentration of 1.32 pounds per acre caused practically no injury on sweet corn, snap bean, mung bean, potato and asparagus. In addition to the above crops, the concentration of .66 pounds per acre caused practically no injury on cucumber, lima bean, pea, and tomato. In general, the concentrations of .13 and .33 pounds of the butyl ester of 2,4-D per acre, were not effective herbicides for any appreciable length of time, while the concentration of .66 pounds per acre gave adequate control of all weeds present for a three week period, and the concentration of 1.32 pounds per acre gave adequate control for about six weeks. The most susceptible vegetable crops included the brassicae, with the exception of radish, the head and leaf lettuce. The important weed species present included crabgrass, pigweed, and purslane. (Contributed by Department of Horticulture, Ohio Agricultural Experiment Station.) (*Agricultural Weed-No-More 40, supplied by the Sherwin-Williams Company)

Spraying beets with salt solution. Bakke, A. L. Young beet plants were sprayed with a concentrated solution of salt. The weight of beets taken from the unsprayed plots was 607 pounds, that from the treated plots 640 pounds. The beets from the control plots showed a sugar content of 15.9 percent while the beets from the salt treated plots had a sugar content of 16.15 percent. There was a saving of 1/3 in labor. Sprayed smartweed grew to a height of 9 inches while the unsprayed plants became 37 inches high. (Contributed by Iowa Agricultural Experiment Station.)

Controlling annual weeds in potato fields with 2,4-D. Bakke, A. L. A number of broad leafed plants are resistant to 2,4-D. In this category is the potato plant. Since many potato fields are heavily infested with smart weeds, pigweeds and lamb's quarter at time of harvest, it seemed feasible to spray potato with 2,4-D when further cultivation will injure roots. Since 2,4-D can be mixed with copper salts and DDT, it appeared logical to add 2,4-D to the Acme Red River Potato Mix where the active ingredients are basic copper arsenate, 56.50 percent dichloro-diphenyl-trichloroethane (DDT) 9.50 percent and inert ingredients 34.00 percent. Two sprayings after July 29 of the mixture served to control the blight leaf hopper and the weeds. To cite one specific example where potato plants were sprayed with the Red River Potato Mix and 2,4-D (Tufor 40, one quart per 100 gals.) the results as determined by the yields were as follows: Sprayed 460 lbs., not sprayed 277 lbs. Whether the potato tubers will keep as well as those which have not been treated will be determined later. (Contributed by Iowa Agricultural Experiment Station.)

Experiments on the resistance of potatoes to 2,4-D. Barrons, Keith C. and Coulter, L. L. In 1946 eight varieties of potatoes were sprayed when six to ten inches tall with herbicidal concentrations of the sodium salt of 2,4-D. Based on plant reaction and tuber formation they appeared to have a high degree of resistance except for Menominee and Russet Rural. Spraying older plants after tubers had set apparently caused yield reductions in all varieties. Tubers from sprayed potatoes stored well and grew normally in 1947. In 1947 Russet Rural, Chippewa, Katahdin, and Green Mountain in a replicated plot test were sprayed when from three to ten inches tall with the sodium salt of 2,4-D at .35 and .70 pound of acid per acre. A trend toward a slight yield reduction under the control was found, but difference was not statistically significant. It is apparent that the low rates of 2,4-D can be used selectively for spot spraying of

perennial weeds in potatoes. It might sometimes be used to advantage for emergency spraying when cultivation is impossible and the plants are still young. Further tests will be required before a recommendation for general spraying of potatoes can be made. (Contributed by Dow Chemical Company, Midland, Michigan.)

Control of weeds in strawberry plantings by the use of 2,4-Dichlorophenoxyacetic acid. Carlson, R. F. Experiments have shown that 2,4-D can be used to control young succulent weeds in strawberry beds. Several concentrations were used ranging from 500 ppm to 2000 ppm. The strawberry plants were affected by the higher concentrations as was indicated by twisting of the petioles and misshapen fruits, while at the low concentrations the effect was slight. The control of weeds was satisfactory at all concentrations. Some varieties of strawberries respond differently to 2,4-D. For example, Robinson is more resistant than Premier. Time of application and concentration of 2,4-D is important. The first year bed can be sprayed as soon as the weeds come up after planting in the spring. Since the 2,4-D has adverse effect on the flower buds, the fruiting bed should not be sprayed until after harvest. Best results were obtained where an aqueous spray of 500 ppm of 2,4-D was used shortly after the weeds had emerged. This concentration killed most of the troublesome broadleaved weeds without injuring the strawberry plants. (Contributed by Michigan Agricultural Experiment Station.)

The use of sodium chloride spray for weed control in onions. Grigsby, B. H. Saturated sodium chloride was applied as a spray to seeded onions at the time when the second true leaf was just emerging. The solution was used at the rate of 100 gallons per acre. On muck soil, no reduction in stand of onions was found and only a slight temporary wilting of the young plants was observed. Satisfactory control of smartweed, ragweed, grasses, pigweed, and cinquefoil was obtained. Lamb's quarters were not affected by the spray. Yellow globe, white globe, and sweet Spanish varieties were included in the tests, but no significant differences in response of varieties were observed. Sweet Spanish types showed a more severe wilting, but recovery occurred in all plots. Yields were not reduced by the salt. (Contributed by Michigan Agricultural Experiment Station, Section of Botany.)

The use of Stoddard solvent in celery. Grigsby, B. H.* Stoddard solvent used at rates of 40, 60, and 100 per acre on celery seed beds gave complete control of weeds in the seed beds. Three applications of the lighter rate were made without injury on any of three varieties of green celery and three varieties of yellow celery. Sprayed and unsprayed lots of each variety were transplanted in July and sprayed two weeks after transplanting. Two-thirds of the plots were sprayed a second time when the celery was 8-10 inches high. One-third received three applications after transplanting. Examination at harvest time, October 1st, showed some injury (black heart) due to the oil spraying. Injury was greatest in the yellow types and plots that had received a seed bed spraying were less injured than those not sprayed in the seedling stage. (*Section of Botany, Michigan Agricultural Experiment Station.)

Stoddard solvents for weed control in carrots and parsnips. Grigsby, B. H.* Three forms of Stoddard solvent, with aromatic contents of 5 percent, 10 percent, and 12 percent, were used at the rate of 100 gallons per acre on carrots and parsnips which had just formed a second true leaf. Satisfactory

weed control, 90 percent of annual weeds, was obtained. These same materials used when carrots were 4-6 inches and weed plants were as tall, or taller than the crop plants. At this stage the 5 percent materials did not give satisfactory control. The 10 percent and 12 percent materials were effective on weeds other than ragweed, beggars tick, and worm seed mustard. Some injury to the outer leaves of the carrots was observed in the 5 percent and 12 percent materials. Recovery occurred and no permanent effects were observed. Stoddard solvents applied to carrots whose roots were 1/2 inch in diameter, produced oily flavor at harvest time. (*Section of Botany, Michigan Agricultural Experiment Station.)

The use of 2,4-D spray for weed control in potatoes. Grigsby, B. H.* Butyl ester, sodium salt, acidified sodium salt, and triethanolamine salt, at the rate of 1 1/4 pounds actual 2,4-D acid were applied to five varieties of potatoes. The potatoes were about one foot in height at the time of application. None of the formulations killed the potatoes but formative effects were observed in some varieties. The acidified sodium salt produced the most severe effects upon foliage and reduced the size and total yield of tubers in all varieties. The Pontiac and Chippewa varieties showed less foliage effects than the Cobbler, White Rose, and Russett Rural varieties. Yields in all varieties were reduced by all formulations used. (*Section of Botany, Michigan Agricultural Experiment Station.)

Chemicals for weed control in asparagus. Grigsby, B. H.* Seventy-five pounds of Cyanamid, dusting grade, per acre applied at a time when weeds were 2 inches or less in height, gave control of lamb's quarters, pigweed, and crabgrass. This quantity was effective when weeds were wet with dew. One hundred twenty-five pounds per acre, applied two later, gave no control of weeds. 2,4-D at the rate of 1 1/4 pounds per acre (sodium salt) applied at the end of the cutting season, gave control of broad leaved weeds in asparagus. This treatment has been applied for two successive seasons and has not produced any apparent ill effects on the asparagus crowns. Young spears, hit by the spray solution have been distorted but new growth produced later in the season was not affected. Control of broad leaved weeds was satisfactory but grasses appeared much more abundantly in sprayed plots than in other areas of the field. (*Section of Botany, Michigan Agricultural Experiment Station.)

Application of 2,4-D to soil as a pre-emergence spray to prevent lodging and to control weeds in sweet corn.* Hammer, C. L., Tukey, H. B., and Carlson, R. F. Following up earlier work in which it was found that 2,4-D could be successfully used as a pre-emergence spray in gladioli plantings, it was found that if the sodium salt of 2,4-D were applied at the rate of five pounds per acre as a pre-emergence spray to corn growing in sandy loam soil, that adequate weed control could be obtained without reducing yield of corn. It was also discovered that the corn growing on the 2,4-D treated soil produced a more extensive root system and a much more developed brace of prop root system. As a result of the root stimulation, the corn plants were better anchored and withstood a severe windstorm which blew over all the corn in the control plots. (*Mich. State Quart. Bull. November 1947.)

The use of 2,4-D on strawberries. Neville, Homer B., Nutter, Eugene C., and Willard, C. J. Three varieties of strawberries, Catskill, Fairfax, and Premier, set out in 1945, were treated on May 15, two days after a heavy frost which killed the first blossoms. The iso-propyl ester and the sodium salt were

used at 1/2, 1, and 2 pounds per acre of 2,4-D acid equivalent. On May 22 there was an estimated 10 percent deviation from normal on the 1 pound rate in the form of the iso-propyl ester and of the 2 pound rate in the form of the sodium salt. Two pounds of acid in the ester form caused an estimated 33 percent deviation from normal. By June 15th, the affected plants were indistinguishable from the untreated. The fruiting stems were as straight, the fruit as perfect, and apparently in as great quantity. It was not possible to make actual yield tests. Later in the summer, applications on the same variety were made during the period of runner formation. The butyl ester and the sodium salt were used in rates up to 1 pound of 2,4-D acid per acre. There was no visible damage to any variety on any plot. Runners continued to set plants after the treatments. (Contributed by The Ohio State University in cooperation with the Dow Chemical Company and the Sherwin-Williams Company.)

Effects of oil sprays on carrots. Spangelo, L. P. and Andersen, E. T. Varsol (3139), diesel fuel (winter) and kerosene (Esso) (all Imperial Oil products) were applied to the foliage of Red Cored Chantenay carrots each at the rate of 80 gallons per acre. The applications were made when the plants were at the four to five leaf stage and three to five inches in height. All three materials were effective in controlling weed growth, which was predominately red-root pigweed (Amaranthus retroflexus L) and purslane (Portulaca oleracea L.) as observed for one week following the treatments. Weeds were then removed in order to obtain accurate data on the effects of the treatments on root yields. Harvesting was done when the plants were mature and the analysis of yield data (root weight) indicated no statistically significant reduction in yields with any of the materials applied. (Contributed by Division of Plant Science, The University of Manitoba.)

Effects of Sinox on onions. Spangelo, L. T. and Andersen, E. T. Sinox was applied to the foliage of Yellow Globe Danvers onions at three concentrations: 1/2, 1, and 1 1/2 gallons in 80 gallons of water, with each applied at an 80 gallons per acre rate. An activator, ammonium sulphate, was used with all treatments at the rate of one pound per 80 gallons of spray solution. The applications were made at two dates. At the first date, the majority of the plants were at the cotyledon leaf stage, with a small proportion having reached the second and third true leaf stages. At the second date the plant height averaged 9 to 10 inches. Analysis of yield data (bulb weight) indicated a statistically significant reduction in yields with all concentrations at the first date and with only the 1 1/2 gallons concentration at the second date. (Contributed by Division of Plant Science, The University of Manitoba.)

Effects of 2,4-D on potatoes and onions. Spangelo, L. P. and Andersen, E. T. The experiments were conducted during the summers of 1946 and 1947. The ammonium salt of 2,4-D was applied to the foliage of Red Warba potatoes and Yellow Globe Danvers onions at four concentrations: 50, 115, 263 and 600 ppm. (parts per million). Each concentration was applied at the rate of 200 gallons per acre. The 600 ppm concentration thus was equal to a 1.20 pounds (pure acid equivalent) per acre rate. The applications were made at three dates. The potato plants were 3 to 6 inches tall at the first date, a few flower buds present at the second date and in full bloom at the third date. With onions in 1946, applications were made on June 12 when the plant height was 5 to 6 inches, on July 2 and on July 19. In 1947 the applications were made on July 14 when the plant height was 2 1/2 to 4 inches, on July 28 and on August 7. Analysis of yield data of potatoes (tuber weight) indicated a statistically significant

trend of increased injury and reduction in yields with increased concentration at the first date. At the second or third dates no such trend was evident. Analysis of yield data of onions, (bulb weight) indicated a similar significant trend at the first date. In 1946 at the second and third dates, no significant reduction was evident. In 1947 there was a statistically significant reduction with the heaviest concentration at the third date. There was no apparent injury to either the tubers or bulbs with any of the treatments. (Contributed by Division of Plant Science, The University of Manitoba.)

Effects of 2,4-D on carrots, beets, turnips and peas. Spangelo, L. P. amd Andersen, E. T. The ammonium salt of 2,4-D was applied to the foliage of carrots, beets, turnips and peas at four concentrations: 50, 115, 263, and 600 ppm (parts per million). Each concentration was applied at the rate of 200 gallons per acre. The 600 ppm concentration thus was equal to a 1.20 pounds (pure acid equivalent) per acre rate. The applications were made at three dates. At the three dates the peas were, respectively, 3 to 6 inches in height, early bloom, and full bloom stages. Analysis of yield data, (pod weight) indicated a statistically significant reduction in yields with the 600 ppm concentration at the first date, with the 263 and 600 ppm concentrations at the second date, and with all concentrations at the third date. Very abnormally shaped and seedless pods resulted from the 600 ppm concentration at the third date. Abnormal leaf shape (linear to lanceolate rather than the normal oval shape) resulted with all concentrations at all dates. A high degree of susceptibility was indicated in these experiments by the 3 vegetables, carrots, beets, and turnips. Even at the lowest rates of treatment a nodular and much deformed root development occurred with all three crops. (Contributed by Division of Plant Science, The University of Manitoba.)

Effects of 2,4-D on sweet corn. Spangelo, L. P. and Andersen, E. T. The sodium salt of 2,4-D was applied to the foliage of Marcross sweet corn at four concentrations: 250, 600, 1000, and 1500 ppm (parts per million). Each concentration was applied at the rate of 100 gallons per acre. The 1000 ppm concentration thus was equal to a one pound (pure acid equivalent) per acre rate. The applications were made at two dates when the plants were, respectively, 5 to 6 inches and 14 to 15 inches tall. Analysis of yield data (kernel weight) indicated no statistically significant reduction in yields with any of the concentrations at either date. Abnormal anchor root growth was very evident in plots of the second application. This effect increased with increased concentration. In many cases such growth prevented the anchor roots from reaching the soil. This could be a significant factor in predisposing plants to lodging. Preliminary tests on stem strength indicated that weakening, near the soil level, had occurred in the abnormal plants. Pre-emergence treatments using two formulations, sodium salt and ester (butyl) at one pound per acre rate gave effective control of annual weeds, which were predominatly red-root pigweed (Amaranthus retroflexus L) and purslane (Portulaca oleracea L) without subsequent injury to the corn plants. (Contributed by Division of Plant Science, The University of Manitoba.)

Effect of the sodium and amine salts of 2,4-D on strawberries. Viehmeyer, Glenn. The effects of the salts of 2,4-D indicate that there is a good possibility of controlling broad leaved annual weeds in this crop by the use of this herbicide. Of forty varieties of strawberry treated at the excessive dosage of approximately six pounds of the free acid, as the sodium salt, a few were killed or so severely damaged that recovery was unsatisfactory, but most

varieties were not seriously affected. Lower dosages of 1 lb. free acid per acre or less have in no case resulted in excessive injury to plants treated at any stage of growth. One lot of the variety Gem treated in full bloom produced an apparently normal crop. Dosages recommended for the control of seedling annual weeds do, on the more susceptible varieties, cause typical distortion of leaf petioles and blades and in some cases injury or death of the growing tips of young runners. However, in most cases observed, the injury was temporary and did not have a permanent effect on the vigor or productivity of the plants. More information on dosage, time and rate of treatment, and effect on yields is needed before the herbicide can be recommended for commercial weed control in strawberries. (Contributed by University of Nebraska, North Platte Substation, North Platte, Nebraska.)

EXPERIMENT V-2
VARIETAL DIFFERENCES IN CROP TOLERANCES TO 2,4-D

REGIONAL SUMMARY

Glenn Viehmeyer 1/

Abstracts and reports from cooperating workers indicate a wide difference in tolerance to 2,4-D exists between varieties of a given crop. Differences in tolerance also exist within a variety at various stages of growth and are also apparently affected in some degree by such environmental factors as type of soil, soil fertility, temperature, etc.

At the present time the picture is not clear cut and the data scanty. A long series of investigations, under a wide variety of field conditions, will be necessary before final determination of varietal differences and their importance from the economic standpoint can be made. Present data, though admittedly fragmentary, seem to indicate that the minimum effective dosages of 2,4-D necessary for control of annual weeds is below the maximum safe dosage on many tolerant crop varieties. They also indicate that, in many cases, dosages recommended at the present time are too high to be used without injury to the crop plant.

A table of maximum safe dosages on various crops and crop varieties is given below. This table is a composite one taken from abstracts and reports from cooperators reporting on Experiments V and V-2. The dosages are those that, apparently, resulted in a minimum amount of injury to the more susceptible varieties of the crop.

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Crop Variety	Maximum safe dosage that can be used without serious injury (lbs. per acre)							
	1*		2*		3*		4*	
	Salt	Ester	Salt	Ester	Salt	Ester	Salt	Ester
Barley								
Club Mariout					0.5	0.25		
Beecher					1.0	0.5		
Velvon	0.5	0.5			1.0	0.5		
Spartan					1.0	0.5		
Sanalta	1.0	1.0	2.0	1.0	2.0	0.5		
Titon	0.5	0.5						
Vantage	1.0	0.5						
Plush	1.0	0.5						
Montcalm			1.0	0.5	0.75	0.25		
Oberbrucker	2.0	2.0	2.0	2.0				
Oats								
Brunker					1.0	1.0		
Kanota	0.5	0.5			1.5	1.0		
Otoe					1.5	1.0		
Osage		0.125		0.125	1.5	1.0	3.0	2.0
Cedar			0.5	0.125	2.0	1.5	3.0	2.0
4301 (Nebr.)		0.125		0.125	1.5	1.0	3.0	2.0
Garry		0.5	1.0	0.5	0.75	0.25		
Exeter		0.5						
Victory		0.5						
Ajax (Scott, Sask)		1.0						
Ajax (Swift Current, Sask)	0.5	0.25						
Larain	3.0	0.5	1.0	0.5	0.5	0.25		
Clinton			1.0	0.8				
Wheat								
Rescue	0.5		0.5	0.25				
Regent	3.0	1.0	1.0					
Redman			1.0	0.5	2.0	0.5		
Apex			1.0	0.5				
Pawnee	0.5	0.25	0.5	0.25	0.5	0.25	1.5	1.0
Thatcher			1.0	0.5				
Nebred	0.5	0.25	0.5	0.25	0.5	0.25	1.5	1.0
Flax								
Royal	0.25	0.1	1.0	0.15	0.5	0.25		
Redwing	1.0	0.25	0.5	0.25	0.5	0.25		
Soybean								
Dunfield	0.25	0.125	0.25	0.125	0.25	0.125	0.25	0.125

* 1-seedling rosette; 2-rapid growth; 3-bloom; 4-post bloom stages of growth.

(Continued)	Maximum safe dosage that can be used without serious injury (lbs. per acre)							
	1*		2*		3*		4*	
Crop Variety	Salt	Ester	Salt	Ester	Salt	Ester	Salt	Ester
Bromegrass								
Lincoln	0.25	0.125	0.5	0.25	2.0	1.0	3.0	2.0
Buffalo Grass								
Common	0.25	0.125	0.25	0.125	2.0	1.0	2.0	1.0
Bluegrass								
Kentucky	0.25	0.125	0.5	0.125	4.0	3.0	4.0	3.0
Wheatgrass								
Intermediate	0.5	0.25	1.0	0.5	6.0	4.0	6.0	4.0
Tall	0.5	0.25	1.0	0.5	6.0	4.0	6.0	4.0
Lovegrass								
Sand	0.5		1.0	0.5	2.0	1.0	2.0	1.0

*1-seedling rosette; 2-rapid growth; 3-bloom; 4-post bloom stages of growth.

ABSTRACTS

Varietial differences in corn hybrids in tolerance to 2,4-D. Buckler, G. F. H.* Nine corn hybrids were sprayed with 2,4-D acid, methyl ester compound, at the rate of 1.0 pound per acre. One gallon of spray was used per square rod. The hybrids used in this experiment are some of the most popular hybrids grown in southwestern Ontario. Upon the basis of the limited data available, the results would indicate the following:

1. There is a marked difference in tolerance among the hybrids to 2,4-D in the methyl ester form.
2. The reduction in stand was most evident with the hybrids, Pioneer 322 and Canada 696.
3. When the percentage of injured plants is considered, the hybrids fall into two distinct groups - very susceptible and moderately tolerant. The first group shows from 27 to 44 percent of the plants severely injured, while the latter group shows less than 10 percent.
4. As the season advanced there was considerable recovery among the hybrids, though those in the susceptible group were not as vigorous as the tolerant group.
5. Effects on yield and kernel quality cannot be ascertained until after harvest, early in November.

(*Sr. Assistant, Forage Crops, Dominion Experimental Station, Harrow, Ontario, Canada.)

Some of the effects of 2,4-D on barley varieties. Derscheid, Lyle A.* Eight varieties of barley, Feebar, Odessa, Spartan, Kindred, Tregal, Wisc. #38, Manchuria and a Peatland x Dryland line, were compared for their responses to 2,4-D. Treatments of one pound of 2,4-D acid equivalent to the acre of a butyl ester, a triethanol amine, and a sodium salt were compared with "no treatment" at four stages of growth. The four stages of growth were (1) seedling, (2) fully tillered, (3) in the boot, and (4) in bloom. All varieties, in all treatments, produced abnormal heads when treated in the seedling stages of growth; no other malformations were observed. These heads produced seed, but did not emerge from the sheath normally; they were pulled out of the sheath backwards by the elongation of the peduncle. The ester produced about 80 percent abnormal heads; the amine about 60 percent, and the sodium salt about 40 percent. One week after the "boot" stage, treatments had been made, several varieties treated with the ester were lodged, Odessa was the most affected. An analysis of variance on yield produced an "F" value for "treatments" that is significant at the 5 percent level and an "F" value for "dates of treatment" that is significant at the 1 percent level. A minimum level of significance for "treatments" reveals that regardless of variety and regardless of date of treatment, the plots treated with the ester produced yields that were significantly lower, at the 5 percent point, than did the plots that were not treated. Likewise, a minimum level of significance reveals that regardless of variety and regardless of treatment, the plots treated in the "tillering stage" produced yields that were significantly higher at the 1 percent point than did plots treated at any other date. The "F" values for the interactions "varieties x treatments" and "varieties x dates" were not significant indicating that a differential response in the yields of these eight varieties to the treatments, or to the dates of treatment, was not obtained. The "F" value for the interaction "treatment x dates of treatment" was also not significant. (*Assistant Agronomist, South Dakota State College, Brookings, South Dakota.)

Some of the effects of 2,4-D on oats varieties. Derscheid, Lyle A.* Nine varieties of oats, Tama, Clinton, Bonda, Mindo, Marian, Vikota, Richland, Trojan and Brunker were compared in triplicate for their response to 2,4-D. Treatments of one pound of 2,4-D acid equivalent to the acre of a butyl ester, Triethanol amine, and a sodium salt were compared with "no treatment" at four stages of growth. The four stages of growth were: (1) seedling, (2) fully tillered, (3) in the boot and (4) in bloom. The ester produced an "onion top" effect on all varieties when applied on the seedling stage of growth. The leaves were curled inward from both edges. This abnormality was most apparent one week after treatment, but was still present, to a lesser degree, at harvest. Many of the sheaths produced two or more panicles. An analysis of variance on yields produced "F" values that were not significant for "treatment", "dates of treatments", and for the interactions "varieties x dates" and "varieties x treatments". Thus significant changes in the yields of oats caused by the different treatments or by the time of application was not established. Likewise a differential response in yields of these nine varieties to the treatments or to dates of treatment was not demonstrated. The interaction "dates x treatments" was found to have a significant "F" value which is probably due to high yields obtained from plots treated with the sodium salt of 2,4-D in the seedling stage and low yields obtained from plots treated with the ester in the fully tillered stage of growth. (*Assistant Agronomist, South Dakota Agricultural Experiment Station.)

Effect of application of two dosages of butyl ester by airplane for weed control in two varieties of oats. Hanson, Noel S.* An airplane spraying experiment was conducted on two varieties of oats in two different fields at Lincoln, Nebraska. The butyl ester of 2,4-D was applied at two dosage levels of 1/4 to 1/2 pound in 2 gallons diesel fuel per acre when the oats plants were 4 to 6 inches tall and in the pre-jointing stage. The spray was applied with a Stearman PT17 biplane with belly tank for the solution, propellor-driven pump, and underwing spray boom. Flight was at the height of approximately 3 feet above ground at 80 miles per hour. Swaths 78 feet wide were covered per flight. Glass slides laid out on the field during the flights intercepted 50 to 65 droplets per square inch. Droplets averaged approximately 1/16 inch in diameter. Results noted at time of maturity indicated an opposite response in the two varieties. The treated Osage variety matured 2-3 days earlier than the untreated. The 4301 variety was delayed in maturity by 2-3 days. An indeterminate type of growth was induced in the 4301 with four different specific stages of tillering -- (1) mature culms (2) early dough stage (3) blossoms in anthesis, and (4) tillers 1 to 3 inches tall. Maturity was uniform in the Osage. Many steril florets were noted in the heads of both varieties when treated. Yield at the 1/4, 1/2 and 0 dosages were 42.2, 41.6, and 75.9 respectively for Osage and 40.9, 32.2, and 70.5, respectively for 4301. (*Assistant Agronomist, Nebraska Experiment Station, Lincoln.)

Varietial differences in tolerance to 2,4-D in strawberries. Viehmeyer, Glenn. The sodium salt of 2,4-D was applied to 40 clones of hybrid strawberries to observe the effect of the chemical on varieties of this fruit. The herbicide was applied heavily so that all parts of the plant, including the buds of the crown, were thoroughly drenched with the 1000 ppm solution. The application was estimated to be about the equivalent of six pounds of the free acid per acre. Effects of the treatment on roots, crowns, foliage, runners and stems were studied. Effects ranging from slight injury to nearly complete kills were found. Some clones were very tolerant while others were comparatively susceptible to the herbicide. Three hybrid progenies and three commercial varieties were included in the test. These were: F_1 Fragaria ovalis x Fairfax; a back cross, Fairfax x (F. ovalis x Fairfax), a double cross, (Fairfax x F. ovalis) x (Dorsett x F. ovalis), and the commercial varieties Dunlap, Midland and Premier. The hybrid progenies all had selections that differed in degree of tolerance to the herbicide and different degrees of tolerance were evident in the three commercial varieties as well. The experiment indicates that differences in tolerance, wide enough to be economically important, exist between strawberry varieties and that some varieties of this fruit possess enough tolerance to 2,4-D to make weed control without serious injury to crop a possibility. (Contributed by University of Nebraska Substation, North Platte, Nebraska.)

Differential response of oats and barley varieties to varied dosages of three types of 2,4-D. Viehmeyer, Glenn, and Wolfe, Henry*. Tests were conducted using four varieties of oats (Brunker, Kanota, Otoe and Osage) and four varieties of barley (Beecher, Club Mariout, Spartan and Velvon) to determine varietial reactions to the herbicide. Three types of 2,4-D (butyl ester, triethanolamine salt and sodium salt) were used at four dosages (1/4, 1/2, 1 and 1 1/2 pounds per acre). Treatments were made June 17 - 18 when a majority of heads were emerging from the sheath. The crops were grown on weed free soil and weeds were not a factor in the check plots. Results: Oats: While data on yield were affected by a part of the test area receiving runoff water following heavy rains during the growing season the greatest decrease in yields

resulted from the 1 and 1 1/2 pound dosages of butyl ester, and with few exceptions reductions were in proportion to the dosages applied. Erratic yields were obtained with both amine and sodium salts with the highest yield obtained from sodium salt. Varietial differences were evident but not particularly significant. With one exception (1 1/2 pounds of butyl ester per acre) the treated Osage variety consistantly outyielded the check plots. With few exceptions Kanota and Otoe varieties showed decreased yields. Brunker was the most erratic showing no clear pattern of response to the chemical. Barley: Barley yields were less erratic and more in relation to the formulation and dosage used. Yields were decreased, the greatest decrease occurring from the butyl ester treatments and in proportion to the dosage. No appreciable varietal differences in yield occurred. Both Beecher and Club Mariout were lodged by the two higher dosages of butyl ester. (*Assistant in Horticulture, North Platte Sub-Station, and Graduate Assistant, respectively, Department of Agronomy, Lincoln, Nebraska.)

A study of differential response of varieties of barley to varied dosages of three types of 2,4-D. Wolfe, Henry, and Viehmeyer, Glenn.* Four varieties of barley (Spartan, Velvon, Club Mariout, and Beecher) were treated with three type formulations of 2,4-D (butyl ester, triethanolamine salt and sodium salt). Dosages of 1/4, 1/2, 1, and 1 1/2 pounds per acre were applied June 17 and 18 at a time when a majority of heads were emerging from the sheath. The varieties of barley were grown on relatively weed-free soil, consequently, competition due to weeds was negligible. Two gross morphological effects, height reduction and lodging, were apparent as results of various formulations and dosages of 2,4-D. In comparison to the check, the height of the varieties of treated barley were reduced from one to five inches. The greatest reduction in height for all varieties was in proportion to the dosage of butyl ester used. Very little variety difference occurred on the butyl ester treated plots; however, all butyl ester treated varieties were considerably shorter than either the amine salt or the sodium salt. A slight variety difference occurred with the amine salts and sodium salt. Considering only height, the varieties Spartan and Club Mariout were more tolerant to the salts than were either Velvon or Beecher. The lodging effect which was evident was confined to the varieties of Beecher and Club Mariout, and at the higher concentration of butyl ester. Lodging occurred forty-eight hours following treatment and remained lodged throughout the experiment. The lodging was caused by bending of the second and third nodes following treatment, and was not due to any weakness of straw. (*Graduate Assistant, Department of Agronomy, University of Nebraska, Lincoln, and Assistant in Horticulture, Experimental Sub-station, North Platte, Nebraska, respectively.)

SUMMARY OF REPORTS ON PRE-EMERGENCE TRIALS

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In this summary, pre-emergence treatment includes any treatments made prior to emergence of the crop whether before or after planting. Three direct comparisons were reported of treatments made before planting vs. applications

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made after planting but before emergence. In sweet corn there was slight difference, in potatoes and onions weed control was poorer in the before planting treatment and the stand and yield of onions were greatly reduced.

Cereals: The results with corn are conflicting. In some instances there was no injury to the crop even when planted immediately after treatment; in others, corn was injured if planted sooner than 3 to 4 weeks after treatment. Several investigators reported an increased yield following treatment; others observed no stimulation of growth or yield. This variation in results is quite evidently not due to differences in formulations or rates of applications but may be due to such factors as soil, climate, and corn variety. Until the factors involved are more thoroughly understood, recommendations should be regional in scope.

Spring wheat and oats were less tolerant than corn in some areas but showed no difference in others. Fall injury to winter wheat, barley and rye was not reflected in the yields. Apparently regional differences apply to these crops also. There was some indication of differential response of these crops to various 2,4-D formulations.

Flax: Flax was more uniformly injured than the cereals at the four locations tried when sown too soon after treatment. Approximately a month must intervene between treatment and date of sowing but rate of application was also an important factor.

Legumes: Alfalfa, sweet clover, and white clover proved susceptible to injury when sown within a month or six weeks after treatment. Peas were somewhat less susceptible and soybeans at two locations showed remarkable tolerance. There was some indication of differential response of alfalfa to formulations of 2,4-D and rate of application was an important factor.

Germination: Tests made at Minnesota on winter wheat, winter rye, oats, flax, corn, and soybeans showed no injury to the viability of seed from crops grown on land treated with 4 lbs. of active ingredient per acre.

Forage grasses: These trials were very limited. They indicate that buffalo grass and intermediate wheatgrass are quite susceptible to injury in the early seedling stage but switchgrass proved very tolerant. Sudan grass is apparently stimulated in growth when sown about two weeks after treatment. In only two trials, millet appeared very tolerant.

Vegetable crops: Limited trials indicate pre-emergence treatment of asparagus, onions, beets, carrots, spinach, tomatoes, and potatoes to be sufficiently promising to merit further research. They indicate differential results can be expected from pre-planting and post-planting applications and from different 2,4-D formulations.

Weeds: Success in controlling weeds by pre-emergence treatment varied widely from perfect control of all annuals including annual grasses in Ohio corn to very moderate control of certain broadleaf annuals and little control of grasses in Minnesota.

Direct comparisons between experiments are impossible because of varying factors. The following indications are shown in the work reported although more

data are necessary before conclusions may be drawn.

1. Dormant seeds are not killed by soil treatments.
2. Weeds in general become more resistant with age; this is particularly true of the grasses. Considerable reduction in annual grasses can be accomplished.
3. Weed seedlings may grow uninhibited if there is inadequate rain and they may emerge later in the season from seeds that did not germinate earlier after toxicity has disappeared from the soil.
4. Smartweed, Russian thistle, and field bindweed seedlings were more resistant than pigweed, lambsquarters, chickweed, shepherds' purse, and purslane but there may be differences in species and strains common to various regions.

ABSTRACTS - CEREALS, FLAX, LEGUMES, AND GRASSES

Residual effects of 2,4-D. Bisal, F. Wheat, corn, peas and flax were sown 1, 18, 32 and 49 days after application of 1 and 2 pounds per acre of 2,4-D. Corn appeared to be entirely immune to the toxic effects of 2,4-D. Both germination and vigor of growth was the same on the treated plots as on plots where no 2,4-D was applied. Of the other crops, wheat was most resistant, followed in order by flax and peas. Wheat seeded 1 and 18 days after the application of 2,4-D had poor germination and considerably stunted growth, but that sown 32 days after the application of the chemical was entirely unaffected, indicating that the toxic effects were dissipated completely within a month. Flax was only slightly more susceptible to the residual effects of 2,4-D. The residual effect from neither the low nor the high rate of application of the chemical exceeded a 49 day period, however. Peas germinated and grew poorly when seeded 32 days after the application of 2,4-D at the high rate of 2 pounds per acre, but no appreciable effect was evident from the 1-pound-per-acre rate. When seeded 49 days after treatment, peas grew normally even on plots receiving a high rate of 2 pounds per acre of 2,4-D. (Contributed by Dominion Soil Research Laboratory, Swift Current, Saskatchewan, Canada.)

Pre-emergence herbicide applications.* Dunham, R. S. and Robinson, R. G. A weed seed mixture was seeded at the rate of 75 wild buckwheat seeds, 45 wild mustard seeds, and 4 wild oat seeds per square foot on a well drained Waukegan silt loam, May 12, 1947. Oats, flax, and alfalfa were seeded with a grain drill and corn and sugar beets were planted with a Planet Jr. The soil surface was not disturbed again for the rest of the season. On May 15 and 16 the following chemicals in water were sprayed on the soil except for the 2,4-D acid dust which was dusted. Sodium salt of 2,4-D at 1, 2, 4, and 6 pounds per acre; butyl ester of 2,4-D at 1, 2, 4, 6, and 9 pounds per acre; amine salt of 2,4-D at 1, 2, 4, and 6 pounds per acre; 2,4-D acid dust at 9 pounds per acre; ammonium thiocyanate at 22, 44, and 88 pounds per acre; 2 percent Sinox W at 109 and 218 gallons per acre; and Sinox General at 3 pints plus 12 gallons diesel fuel oil plus 87 gallons water per acre. 2,4-D rates were based on acid equivalent and treatments were replicated three times. Oats, flax, alfalfa, sugar beets, and wild mustard had emerged by May 20. The sugar beet and corn plots were later abandoned because of uniformly poor stands. 2,4-D formulations at the 2 lb. rate eliminated mustard and alfalfa but did not significantly reduce the yields of oats and flax. Even at 6 lbs., oats and flax yields were not reduced by the so-

dium and amine salts; buckwheat control in June was fair at this rate. Two percent Sinox W at either rate gave excellent mustard control, good wild buckwheat control in June, and no crop injury. 2,4-D acid dust, Sinox General, and ammonium thiocyanate were not satisfactory. Ammonium thiocyanate at 88 pounds appeared to be a good soil sterilizer for about 45 days. None of the treatments resulted in satisfactory control of wild oats. Germination of flax and oats harvested from these plots was not affected by the chemical treatments. (Contributed by University of Minnesota, St. Paul, Division of Agronomy and Plant Genetics.) (*Paper No. 611 of the Misc. Journal Series, Minn. Agricultural Experiment Station.)

Residual effect of 2,4-D sprayed on soil in fall.* Dunham, R. S. and Robinson, R. G. On August 31, 1946, the ammonium salt, sodium salt, and butyl ester of 2,4-D were sprayed on Waukegan silt loam soil at the rate of four pounds of active ingredient per acre. Plots were replicated four times. On September 12, 1946, winter rye, winter wheat, and alfalfa were seeded across all plots. Rye and alfalfa were injured on all treated plots. Rye completely recovered by spring but the alfalfa winterkilled on all plots, including the check plots. On May 10, 1947, oats, flax, alfalfa, red clover, Kentucky bluegrass, sugar beets, and corn were planted on all plots with a Planet Jr. planter without any seedbed preparation. The 2,4-D formulations had no injurious effect on crop growth in 1947 or on the germination of seed harvested from rye, winter wheat, oats, flax, soybeans, and corn in 1947. Marsh cress (Roripa sessiliflora), shepherds purse (Capsella bursa pastoris) and pigweed (Amaranthus retroflexus) were controlled from 33 to 100 percent but smartweed and black nightshade (Solanum nigrum) were unaffected. (Contributed by University of Minnesota, St. Paul, Division of Agronomy and Plant Genetics.) (*Paper No. 608 of the Misc. Journal Series, Minn. Agricultural Experiment Station.)

Residual effect of 2,4-D sprayed on soil in spring.* Dunham, R. S. and Robinson, R. G. On May 22, 1947, 2,4-D amine at the rates of one and two pounds per acre was sprayed on Waukegan silt loam soil. Plots were replicated three times. On May 24, 1947, oats, flax, medium red clover, corn, soybeans, and sugar beets were planted on all plots with a Planet Jr. planter. A second planting of oats was made May 28; a second planting of corn, soybeans, and sugar beets May 31; a second planting of flax and red clover June 10; and a third planting of red clover June 20. The soil surface on these plots was undisturbed after spraying except for the rows made with the planter. The first planting of red clover was injured, and the flax stand on the first planting was slightly reduced. Otherwise, no crop injury was observed. Lambsquarters (Chenopodium album) was well controlled, pigweed was fairly well controlled, and black nightshade was unaffected. Fair control of green and yellow foxtail (Setaria spp.) was obtained for a short time on the treated plots. In the middle of July, all crops but the oats and first planting of flax were mowed because of the heavy growth of grass weeds. The first two plantings of oats and the first planting of flax on the treated plots developed normally and seed harvested from these plots germinated as well as seed from the check plots. (Contributed by University of Minnesota, St. Paul, Division of Agronomy and Plant Genetics.) (*Paper No. 610 of the Misc. Journal Series, Minn. Agricultural Experiment Station.)

Weed control in corn with 2,4-D soil treatments. Hernandez, T. P., Warren, G. F., and Buchholtz, K. P. Two replicated experiments were conducted

on silt loam soil in 1947 with Golden Cross Bantam sweet corn using the sodium salt of 2,4-D. The rates of application were 2 and 4 pounds per acre of the 2,4-D acid equivalent, each being applied as a pre-planting treatment worked into the soil and as a surface application immediately after planting. In one experiment there was no reduction in stand, maturity, or yield of sweet corn. In the other, however, all 2,4-D treatments caused a delay in maturity and a reduction in yield of approximately 12 and 30 percent for the 2 and 4 pound rates, respectively. There was only a slight difference between treatments worked into the soil and those applied to the surface. In an experiment with field corn, 2, 4, and 8 pounds of 2,4-D were applied to the surface of the soil following the planting of a single hybrid, $R_3 \times M_{13}$. The stand and yield were reduced by approximately 12, 50, and 90 percent for the 2, 4, and 8 pound rates, respectively. Significant reductions in weed counts were obtained in all the treatments but weed control was generally better with the 4 and 8 pound applications. Compared with the checks the reduction in number was 50 to 80 percent for the grasses and 40 to 100 percent for the broadleaves. The weeds were mostly witch grass (Panicum capillari), foxtail (Setaria spp.), purslane (Portulaca oleracea), lambsquarters (Chenopodium album), and pigweed (Amaranthus retroflexus). All plots including the check were weeded at the time the counts were taken. (Contributed by University of Wisconsin, Madison, Wisconsin.)

Pre-emergence treatment of soybeans with 2,4-D. Neville, Homer B. and Willard, C. J. In connection with the pre-emergence experiment with corn, three rows of soybeans were interplanted between the corn rows on all plots Unexpectedly, they gave perfect stands in all treatments. Soybeans which were treated immediately after planting with the butyl ester of 2,4-D in oil at the rate of 6 pounds per acre of acid equivalent made a perfect stand and growth, as they did at all lower rates. There was no difference between the soybeans in the checks and the soybeans in the treated plots in germination, standing, or growth. Yield measurements were not taken. This is contrary to the results of other experimenters here at Columbus and to our own experiments in other locations. On June 5 a patch of Canada thistles was treated with butyl ester of 2,4-D at the rate of 4 lbs. acid equivalent per acre. Soybeans were planted in this field on June 11. There was delayed emergence, some loss of stand, and stunted growth. Nevertheless, by August it was difficult to find the treated area. Another patch of Canada thistle was treated on June 20 and soybeans planted in rows on July 1 without reworking the soil. Two soil types were included in this plot, Miami silty clay loam and Brookston silty clay loam. On the Miami, a light-colored low organic soil, the stand and growth of soybeans was extremely poor -- commercially a failure. On the Brookston soil the stand and growth were injured but the damage was less severe and a partial crop was obtained. We do not recommend pre-emergence treatment of soybeans with 2,4-D, but if it could be worked out it would be more important than with corn. (Contributed by Ohio Agricultural Experiment Station in cooperation with the Sherwin-Williams Company.)

Effect on crop plants of residual 2,4-D in the soil. Olson, P. J. and Zalik, Saul. The crops involved were barley, flax, millet, alfalfa, and corn. Ester (butyl) and sodium salt were compared. One pound per acre was the rate used. The application was made May 21. Each of the crops was sown on the treated soil, and on untreated checks on five dates; namely, May 17, June 3, June 16, July 2, and July 17. For practical reasons the crop from the fifth date was used only in the case of corn. Yield of dry matter in pounds was the criterion of treatment effect. The 2,4-D treatments did not reduce significantly the

yields of any of the crops sown on the first date. Barley, millet, and corn were not adversely affected at any date. In the case of corn there was an increase in yield as a result of treatment at each date. This may have been largely due to weed control. Although the plan was to keep the crop weed free it was not practically possible to accomplish this during the earlier states of the experiment. Alfalfa showed a significant reduction at each of the 2nd and 3rd dates, that at the 2nd being greatest. Flax showed a significant reduction at the 2nd date only. There was no significant difference as between ester and sodium salt as to response. (Contributed by Division of Plant Science, The University of Manitoba, Winnipeg, Canada.)

The effects on crop plants of pre-emergence treatment with 2,4-D. Timmons, F. L.*. Soil applications of the sodium salt and triethanolamine salt of 2,4-D at 2 pounds per acre (acid basis) and the butyl ester of 2,4-D at 2 pounds per acre (ester basis) were made August 30, 1946. Duplicated single-row plantings of winter wheat, winter barley, alfalfa, intermediate wheat grass, and peas were made August 30, September 13, September 27, and October 11 across the treated and untreated plots. A rain of 3.76 inches was received September 6 after wheat, barley, and peas had emerged. Total rainfall received September 6 to October 11 was 7.85 inches. All treatments prevented nearly all emergence of alfalfa from the first two plantings but did not greatly reduce the stands from later seedings. The stands of peas from the second planting were reduced somewhat, but were normal for all other seedings. The stands of wheat and barley from the first three plantings were reduced only slightly. Yields of wheat were erratic but average about the same on treated and untreated controls. Yields of winter barley tended to be greater on treated plots, particularly, for the first two plantings which winter killed much more severely on untreated plots. Yields of alfalfa were reduced relatively more than stands while yields of intermediate wheat grass showed about the same relationships as stands. The triethanolamine salt tended to reduce stands and yields of crops slightly more than did the sodium salt while the butyl ester at a lighter rate (on the acid basis) was less detrimental. (*Agronomist, USDA, Bureau of Plant Industry, Soils and Agricultural Engineering, cooperating with the Fort Hays Branch of the Kansas Agricultural Experiment Station, Hays, Kansas.)

The effects on crop plants of pre-emergence treatments with 2,4-D and Methoxone. Timmons, F. L.*. Soil applications of isopropyl ester, sodium salt, and triethanolamine salt of 2,4-D and Methoxone were made April 18, 1947, at 2 pounds per acre (acid basis). The sodium salt was also applied at rates of 1 to 4 pounds per acre. Duplicated single row plantings of alfalfa, buffalo grass, corn, Midland milo, and Sudan grass were made April 18, May 2, May 22, and June 2 across the treated plots and untreated control plots. Rainfall received after treatments included: .18 inch, April 25; 3.29 inches, May 2-22; and 5.41 inches, May 2 - June 2. Stands of all crops from the first two plantings were reduced considerably by all treatments, the reduction for the second planting being greater in most cases. Normal stands of buffalo grass, corn, milo, and Sudan were obtained on nearly all treated plots from plantings made May 22 and June 2 while alfalfa planted June 2 produced nearly normal stands. Crop yields on treated plots, expressed as percentage of yields on untreated control plots were relatively greater than stands in nearly all cases. Effects of 2,4-D reduced the yields of alfalfa and milo from the first two or three plantings but increased the yields of Sudan grass from nearly all plantings and increased the yields of corn and milo planted June 2. The increases ranged up to 38 percent more than untreated controls. No significant differences were

apparent in the effects of different 2,4-D formulations or Methoxone at equivalent rates. (*Agronomist, USDA, Bureau of Plant Industry, Soils and Agricultural Engineering, cooperating with the Fort Hays Branch of the Kansas Agricultural Experiment Station, Hays, Kansas.)

The effect on crop plants of pre-emergence treatments with 2,4-D. Timmons, F. L.*. Spray applications of the sodium salt, triethanolamine salt, and isopropyl ester of 2,4-D and of Methoxone were made May 22 at 2 pounds per acre (acid basis) on fallow land that had been prepared for seeding crops. The sodium salt was also applied at rates of 1 and 4 lbs. of 2,4-D per acre. Duplicated single-row plantings of alfalfa, buffalo grass, corn, Midland milo, and Sudan grass were made across the treated and untreated plots May 22, June 2, and June 14. Frequent showers which began May 24 totalled 2.02 inches before June 2 and 6.90 inches before June 14. The stands of all crops from the May 22 planting were greatly reduced by all treatments with corn showing considerably more tolerance than other crops. Stands of all crops from the June 2 planting were much better but were only 7 to 39 percent for alfalfa. Stands of crops planted June 14 were nearly normal. Crop yields tended to be relatively greater than stands on the treated plots. Detrimental effects were in proportion to the rate of 2,4-D applied but showed no clear-cut differences between the different types of 2,4-D or Methoxone. Yields of milo from the June 2 planting and of Sudan grass from the June 2 and 14 plantings were, in most cases, considerably greater on treated plots than on untreated controls. The increases ranged up to 52 percent for milo and 71 percent for Sudan grass. Yields of Sudan grass on treated plots were relatively much greater for the second cutting than the first cutting. (*Agronomist, USDA, Bureau of Plant Industry, Soils and Agricultural Engineering, cooperating with the Fort Hays Branch of the Kansas Agricultural Experiment Station, Hays, Kansas.)

Effect of residual 2,4-D in the soil on alfalfa, sweet clover and switch grass. Viehmeyer, Glenn, and McDermand, John. One, two and four pounds per acre of 2,4-D as the sodium salt were applied to a seedbed to be planted to the above crops on April 1, April 16, May 1, and May 16, 1947. The ground was seeded on the latter date. Alfalfa and sweet clover emerged and grew normally on soil receiving the earliest treatment. On soil receiving the April 16 treatment the stand was reduced 95 percent and on soil receiving the May 1 and 16 treatments no plants emerged. Switch grass gave a full stand on soils receiving all treatments. At the heaviest application applied on the latest date (4 lbs. on May 16) emergence was delayed 10 to 15 days and seedlings showed stunting but soon recovered and made apparently normal plants. Some seed was produced on these plants. (Contributed by University of Nebraska Sub-Station, North Platte, Nebraska.)

A study of the possible stimulation of corn by 2,4-D. Willard, C. J. and Neville, Homer B. Because of numerous reports of stimulation of corn by 2,4-D a definite attempt to produce stimulation by pre-emergence treatments was made. A total of 106 plots were treated at periods before planting ranging from 48 days to 22 days and also immediately after planting and at rates ranging from 1/2 to 3 pounds of 2,4-D acid equivalent per acre. In one set the plots were replicated three times and the other five times in a randomized block experiment. Heights of plants were taken during the rapid growth stage before tasseling when differences in height are most obvious. The yields of grain were taken at maturity. At no time during the season were there any visible differences between any of the plots or the checks which were in any way related to treatment. In the early planting the average yield of the untreated checks was 73.7 bushels

and of all treated plots was 73.0 bushels. In the late planting the average yield of the untreated checks was 59.9 bushels and the average yield of all treated plots was 58.7 bushels. The average height varied by .1 of an inch in the early planting and .7 of an inch in the late planting. There were no significant differences in height or yield between any treatment in the series. In this experiment the treatment produced no perceptible or significant stimulation of corn in height or yield. (Contributed by Ohio Agricultural Experiment Station in cooperation with Sherwin-Williams Company.)

Pre-emergence treatment of corn with 2,4-D. Willard, C. J. and Neville, Homer B. Corn was planted August 1 in a poor seedbed on Brookston silty clay loam soil and 2,4-D applied as concentrated (5 gallons per acre of water, 6 gallons per acre of oil) spray immediately afterwards. The butyl ester of 2,4-D was applied at rates of 1, 2, 3, and 6 pounds of acid equivalent per acre in oil and 1, 2, and 3 pounds per acre in water. The triethanolamine was applied at 1, 2 and 3 pounds per acre in water. Poor stands were obtained in all plots including checks, because of the poor seedbed. The plot chosen was heavily infested with annual weeds. All 2,4-D treatments of 2 pounds per acre or more of acid controlled the annuals to the extent that no cultivation was necessary. One pound per acre of acid equivalent gave fair, but not really satisfactory, control. All annual weeds, including crabgrass and other summer annual grasses, were controlled. Hedge bindweed was definitely affected, though not completely controlled, by 2 pounds per acre and up. Canada thistle and ground cherry were not affected even by six pounds. There was no apparent injury to the stand or growth of the corn. Yields were not taken. In experiments planted earlier, where good stands were obtained, applications to 31 plots at rates ranging from 1/2 to 3 pounds per acre of acid equivalent, mainly of the butyl ester, but also of the triethanolamine and sodium salts, were made with no measurable effect on stand or yield from the treatment. Pre-emergence treatments seem definitely less likely to injure corn on these heavy soils than post-emergence treatments. (Contributed by Ohio Agricultural Experiment Station in cooperation with the Sherwin-Williams Company.)

VEGETABLES

Effect on crop plants of residual 2,4-D in the soil. Bordeleau, R. A sodium salt (Herbate C.I.L.) was applied at three different concentrations 500, 1000, and 2000 ppm at the rate of 1 1/2 gallon per square rod. A check plot was provided for comparison purposes. The soil was treated on June 17 and the first precipitation, 0.45 inches, occurred 7 hours after treatment. Oats, white clover, corn, flax, and timothy were sown on June 17, July 5, July 21, and August 2. Oats: At all dates of sowing germination was 100 percent. With the sowing of June 17 and July 5, in the treated plots, oats had a tendency to yellow, about 50 percent died. However, there was no residual effect after 30 days. White Clover: Practically all destroyed at first sowing. No effect on sowings made after 15 days. Corn: No residual effect of 2,4-D on corn. Flax: Completely destroyed at first sowing. Good results with subsequent sowings. Timothy: Germination 100 percent in all sowings. All died in all treatments as well as in the check. (Contributed by Dominion Experimental Station, L' Assomption, Quebec, Canada.

Weed control in potatoes with 2,4-D. Hernandez, T. P. and Warren, F. F. A replicated experiment was conducted with Chippewa potatoes on peat soil using the sodium salt of 2,4-D. It was applied as soil treatments at the rates of 2 and 4 pounds per acre of the 2,4-D acid equivalent, each as a pre-planting treatment worked into the soil 3 inches deep, as a surface application immediately after planting, and as a pre-emergence spray just before the potatoes came up. In addition, one treatment was applied as a direct spray of 1000 ppm at 100 gallons per acre when the potatoes were approximately 8 inches tall. The direct spray severely stunted the potatoes for a period of approximately 2 weeks but later they appeared normal. None of the treatments gave a significant reduction in yield compared with the check and there was no apparent effect on tuber quality. The direct spray gave nearly 100 percent control of the weeds present which were mostly pigweed (Amaranthus retroflexus). As compared with the checks, the 2 pound soil applications reduced the number of weeds by 38 to 60 percent and the 4 pound applications gave a 64 to 74 percent reduction. The weeds not killed were severely stunted. Weed control was slightly better where the 2,4-D was applied to the soil surface than where it was worked in before planting. (Contributed by University of Wisconsin, Madison, Wisconsin.)

Weed control in asparagus. Hernandez, T. P. and Warren, G. F. An experiment was conducted in 1947 in an eight year old asparagus bed on silt loam soil to compare the sodium salt of 2,4-D acid equivalent with Granular Cyanamid as herbicides. The treatments consisted of 4 pounds of 2,4-D per acre applied as a surface application early in the spring before any spears were showing and 375 pounds of Cyanamid per acre concentrated in an 18 inch band over the row when the weeds were about 2 to 3 inches tall. Ammonium nitrate was added to the 2,4-D plots and the checks to give the same amount of nitrogen as supplied by the Cyanamid. Neither of the treatments effected the yield or appearance of the asparagus spears as compared with the checks. Both treatments gave approximately a 90 percent reduction in the number of weeds which consisted mostly of mouse-ear chickweed (Cerastium spp.) and shepherds purse (Capsella bursapastoris). (Contributed by University of Wisconsin, Madison, Wisconsin.

Effect on crop plants of residual 2,4-D in the soil. Harrison, T. B. The 2,4-D (Herbate-Ammonium Salt 77.6% acid equivalent) was applied in liquid form on sandy soil at two strengths, namely one and two pounds per acre, down two strips a rod wide separated by a control strip on May 27 immediately after planting across these strips set onions, beets, carrots, snap beans, sweet corn, and tomato seed mixed with radish seed. One week, two weeks, and one month later similar plantings were made across the treated strips except that tomato transplants were substituted for the tomato seed mixed with radish seed. In general the ground application of 2,4-D restricted the development of broad leaved weeds such as lambs' quarters and pigweed but later the treated plots became heavily infested with five finger grass and foxtail. The stand of beets and carrots was somewhat reduced by 2,4-D applied immediately after seeding and an abnormal forking of the carrot root occurred. The yield of set onions and snap beans was also reduced by the application of 2,4-D immediately after seeding. Sweet corn and tomatoes, however, were not affected by 2,4-D. The detrimental effect of the 2,4-D on the seed and plant development of beets, carrots, snap beans and set onions had altogether disappeared after two weeks as indicated by the growth response of the plantings made two weeks after the ground application of 2,4-D. (Contributed by Dominion Experimental Station, Harrow, Ontario, Canada.)

The use of 2,4-D for pre-emergence weed control in vegetable crops.* Nylund, R. E. A preliminary test was conducted in 1947 in which the sodium salt of 2,4-D was applied on May 22 at the rate of 9 grams per square rod to peat soil in which spinach, beet, onion, and carrot seed has been sown on May 13. The 2,4-D was applied as a dust to the soil surface using sand as a carrier. At the time of application of the 2,4-D some spinach and beets had already emerged and were subsequently killed by the acid. However, later emerging spinach and beets and the carrots and onions were not visibly injured, while all the weed species present or emerging at the time of 2,4-D application, with the exception of Lady's-tongue smartweed (Polygonum persicaria L.), were killed. Evidently non-germinating seeds were not injured as weeds were abundant in the field later in the season. This study will be continued and expanded in 1948. (Contributed by University of Minnesota, St. Paul, Division of Horticulture.) (*Paper No. 605 of the Misc. Journal Series, Minn. Agricultural Experiment Station.)

Weed control in onions with 2,4-D soil treatments. Warren, G. F. Several replicated experiments were conducted in 1947 to study the effect of applying 2, 3, and 4 pounds per acre of 2,4-D acid equivalent to peat soils as pre-planting and pre-emergence treatments to control weeds in field-sown onions. Pre-emergence sprays of the sodium salt of 2,4-D applied just before the onions broke through the ground gave from 50 to 90 percent reduction in the number of weeds present at the time of the first weeding. The weeds which were not killed were severely stunted. The reduction was much less for the second weeding, varying from 0 to 30 percent. Four pounds per acre gave only slightly better control than 2 pounds. The treatments were about equally effective on pigweed (Amaranthus retroflexus), lambs' quarters (Chenopodium album), purslane (Portulaca oleracea) and several other weeds, but smartweed (Polygonum spp.) showed considerable resistance. There was no reduction in either the stand or yield of onions due to these pre-emergence sprays except in two experiments on poorly drained peat. In the latter tests, the injury varied from moderate at 2 pounds per acre to severe at 4 pounds. It is suggested that 2 pounds per acre would be an appropriate rate of application for future tests. A comparison was made of the sodium salt, amine salt, and isopropyl ester preparations as pre-emergence sprays. These three preparations gave comparable weed control but the ester reduced the stand and yield of onions by 40 percent and was therefore unsatisfactory. When 2,4-D was applied to the soil and worked in before planting, weed control was not as good as with pre-emergence sprays and the stand and yield of onions was greatly reduced. (Contributed by Department of Horticulture, University of Wisconsin, Madison, Wisconsin.)

WEEDS

The effectiveness of pre-emergence treatments with 2,4-D and Methoxone in controlling annual weeds. Timmons, F. L.*. Soil applications of isopropyl ester, sodium salt, and triethanolamine salt of 2,4-D and Methoxone were made April 18, 1947, at 2 pounds per acre (acid basis) on land that had not been tilled since fall, 1946. The sodium salt was also applied at rates of 1 and 4 pounds per acre. Part of the treated plots and untreated control plots was cultivated May 20, while the remainder was left without tillage. Little rainfall was received after the chemical treatments until May 12 after which 12.0

inches were received before June 26 when the results were recorded. Emergence of Russian thistle (Salsola kali var. tenuifolia), rough pigweed (Amaranthus retroflexus), and tumbling pigweed (A. graecizans) occurred before rain was received to carry the chemicals into the soil and the stands of these weeds as recorded June 26 averaged as great on treated plots as on untreated controls. However, stands of the later emerging green foxtail (Setaria viridis), stink grass (Erogrostis cilianensis) and witch grass (Panicum capillare) were reduced 57 to 89 percent by the 2,4-D treatments. On the land that was cultivated May 20 subsequent emergence of all weeds was reduced 50 to 84 percent by the different chemicals at 2 pounds per acre and 91 to 98 percent by the sodium salt of 2,4-D at 4 pounds per acre. The grasses were controlled as well as the pigweeds or Russian thistle. There was no significant differences in the effectiveness of the different chemicals at equivalent rates. (*Agronomist, USDA, Bureau of Plant Industry, Soils and Agricultural Engineering, cooperating with Fort Hays Branch of the Kansas Agricultural Experiment Station, Hays, Kansas.)

The effectiveness of pre-emergence treatments with 2,4-D and Methoxone in controlling annual weeds. Timmons, F. L.* Soil applications of isopropyl ester, sodium salt, and triethanolamine salt of 2,4-D and Methoxone were made May 22, 1947, at 2 pounds per acre (acid basis) on land prepared for seeding crops. The sodium salt of 2,4-D was also applied at rates of 1 and 4 pounds per acre. A rain of .85 inch was received May 24 and rains totaling 8.79 inches were received during the next thirty days. Results were recorded July 15. The triethanolamine salt and isopropyl ester of 2,4-D at 2 pounds per acre and the sodium salt at 4 pounds per acre reduced the stands of pigweeds, mat spurge, green foxtail, stink grass, and witch grass 92 to 100 percent and Russian thistle 80 to 90 percent as compared with untreated controls. Methoxone and the sodium salt of 2,4-D at 2 pounds per acre were somewhat less effective in controlling these species. Russian thistle was more resistant to all treatments than other small seeded species while the grasses were, surprisingly, the most effectively controlled. Seedlings of field bindweed were not effectively controlled over the 54 days period by any of the treatments. No earlier observations were made to determine whether effective control of bindweed seedlings over a shorter period resulted from any of the treatments. (*Agronomist, USDA, Bureau of Plant Industry, Soils and Agricultural Engineering, cooperating with Fort Hays Branch of the Kansas Agricultural Experiment Station.)

Effectiveness of 2,4-D soil treatments in controlling seedlings of three annual weeds. Viehmeyer, Glenn and McDermand, John. One, two and four pounds of 2,4-D as the sodium salt was applied to a seedbed April 1, April 16, May 1 and May 16 to observe effects on weed populations through the growing season. Four replications of each treatment were made. The effect on stand of kochia, rough pigweed and barnyard grass was observed. The April 1 treatment was ineffective, possibly due to the effect of the chemical being lost while seeds were still dormant. The April 16 treatment gave stand reduction for kochia 51, 85 and 94 percent; pigweed 50, 75, and 93 percent; barnyard grass no data (excessive growth of kochia prevented growth of barnyard grass), 79 and 98 percent for the 1, 2, and 4 pound applications respectively. The May 1 treatment, kochia 59, 83, and 87 percent; pigweed 27, 66 and 85 percent; barnyard grass 84, 59 and 66 percent reduction for the 1, 2, and 4 pound rates. May 16 treatments, kochia 36, 64 and 87 percent; pigweed 82, 95 and 91 percent; barnyard grass 36, 15 and 36 percent stand reduction for the 1, 2, and 4 pound dosages. The lower reductions of barnyard grass from the May 1 and 16 treat-

ments was apparently due to seedlings that had emerged before treatment and reached a stage where tolerance had increased. The results, while inconclusive, indicate that additional investigation of pre-emergence treatments should be continued. (Contributed by University of Nebraska Sub-station, North Platte, Nebraska.)

ADDITIONAL ABSTRACTS

Effect of activated carbon in reducing the 2,4-D injury to sweetpotato sprouts. Arle, H. F., Leonard, O. A., and Harris, V. C. Sarpy fine sandy loam was sprayed with the sodium salt of 2,4-D at the rates of 1.3, 2.6, 3.9, and 5.2 pounds of 2,4-D per acre on May 28, 1947. Porto Rico sweetpotato sprouts were moistened with water and separated into two groups. One group of plants had the roots dusted thoroughly with activated carbon (Norit A), and the other group remained untreated. Both lots were planted at once in the usual manner, by forcing the roots into the 2,4-D treated soil using a stick. The activated carbon protected the sweetpotato sprouts completely against the 1.3 pound rate of 2,4-D. The higher rates of 2,4-D resulted in a loss of some plants, even when the activated carbon was used. The yield was approximately zero when activated carbon was not used on the 2,4-D plots. The yield from the 2,4-D plots having the activated carbon treatment was not noticeably different from the check plots, when plant survival is considered. The yields were: Check, 319 bu.; 1000 ppm, 324 bu.; 2000 ppm, 298 bu.; 3000 ppm, 246 bu.; 4000 ppm, 234 bu. (Contributed by U. S. Department of Agriculture, Division of Cereal Crops and Diseases, and Mississippi Agricultural Experiment Station, Dept. of Plant Pathology and Physiology.)

Sodium salt of 2,4-D as a pre-emergence herbicide for corn, soybeans, lima beans and cotton. Leonard, O. A., Arle, H. F., Harris, V. C. Sarpy fine sandy loam was sprayed with the sodium salt of 2,4-D directly after several crops were placed, including corn, soybeans, lima beans, and cotton. Applications of 2,4-D were made at the rates of 1.3, 2.6, 3.9, and 5.2 pounds per acre (June 28, 1947). Just before planting, one-half of the seed were moistened with water and dusted with activated carbon (Norit A). The activated carbon had no visible effect in reducing the 2,4-D injury to cotton or any of the other seedlings. The corn, soybeans, and lima beans showed no lasting injurious effect to any of the 2,4-D treatments. An abundance of nodules were present on all of the soybean plants. Both the soybeans and lima beans produced a heavy load of fruit (except for the check plots, which were overrun with weeds). Cotton that survived the 2,4-D treatment recovered very slowly from the effects of 2,4-D. (Contributed by Mississippi Agricultural Experiment Station, Dept. of Plant Pathology and Physiology, and U. S. Department of Agriculture, Division of Cereal Crops and Diseases.

Dow selective as a pre-emergence herbicide for large-seeded crops. Leonard, O. A., Arle, H. F., and Harris, V. C. Dow selective (27% ammonium dinitro-secondary butyl phenol) was sprayed on freshly prepared Ruston sandy loam immediately after Dixie 11 (field corn), string beans, Ogden soybeans, and D. & P. L. cotton were planted (April 21-22, 1947). The rates of Dow Selective used were 1/2, 2, 4, and 6 gallons per acre (made up to 155 gallons per acre with water). The seed were planted about 1 1/2 inches deep. Two gallons of Dow Selective per acre gave almost complete control of all annual

weeds (Richardia scabra was the main weed present) for more than six weeks without injuring the crop plants. The six gallon rate produced some injury to the cotton hypocotyls, while the 1/2 gallon rate did not control the annual weeds. (Contributed by Mississippi Agricultural Experiment Station, Dept. of Plant Pathology and Physiology, and U.S. Department of Agriculture, Division of Cereal Crops and Diseases.)

Sodium salt of 2,4-D as a pre-emergence herbicide for field corn. Leonard, O. A., Arle, H. F., and Harris, V. C. Leeper fine sandy loam was sprayed with solutions of the sodium salt of 2,4-D immediately after field corn (Dixie 11) was planted (July 1, 1947). 2,4-D was applied at the rates of 1.3, 2.6, 3.9, and 5.2 pounds per acre. Half of each plot was hoed in order to evaluate the effect of 2,4-D on the corn independently of weeds. The 2.6 pound rate gave excellent control of all annual weeds (crab grass, Euphorbia sp., annual morning glory, spring and smooth pigweed, cocklebur), and even Johnson grass (a perennial) seemed to suffer because of crop competition. The corn yields appeared to be unaffected by the 2,4-D treatments. The yields were: Check (hoed) 35 bu.; 1.3 pounds 2,4-D, 36 bu.; 2.6 pounds 2,4-D, 37 bu.; 3.9 pounds 2,4-D, 35 bu.; 5.2 pounds 2,4-D, 34 bu. The unhoed check had 22 bushels of corn per acre. (Contributed by Mississippi Agricultural Experiment Station, Dept. of Plant Pathology and Physiology, and U. S. Department of Agriculture, Division of Cereal Crops and Diseases.)

Dow Selective and Sinox W as pre-emergence herbicides for peas. Leonard, O. A., Arle, H. F., and Harris, V. C. One and one-half gallons and six gallons each of Dow Selective (27% ammonium dinitro-secondary butyl phenol) and Sinox W (13% of the same active ingredient) were sprayed on Leeper fine sandy loam, directly after peas, cabbage, rape, collards, and lettuce were planted (September 25). The six gallon rates of both materials controlled all weeds (Crab grass, smooth and spring pigweed, annual morning glory, etc.) for more than six weeks. The peas were not affected visibly by the treatments, but the other crops were killed, with the exception of some survival of rape with 6 gallons of Sinox W. The 1 1/2 gallon rate of Dow Selective also gave excellent weed control with the exception of annual morning glory. The peas were not injured and the rape only slightly affected. The 1 1/2 gallon rate of Sinox W did not control annual weeds. (Contributed by Mississippi Agricultural Experiment Station, Dept. of Plant Pathology and Physiology, and U. S. Department of Agriculture, Division of Cereal Crops and Diseases.)

Sinox W and Dow Selective as pre-emergence herbicides for cotton. Leonard, O. A., Harris, V. C., and Arle, H. F. Sinox W (13% ammonium dinitro-secondary butyl phenol) and Dow Selective (27% of the same active ingredient) were sprayed on Sarpy fine sandy loam two days after cotton was planted. Sinox W was applied at the rates of 1 1/2 and 6 gallons per acre and Dow Selective at the rates of 1/2 and 2 gallons per acre (May 13, 1947). The 6-gallon rate of Sinox controlled the annual weeds (crab grass, annual morning glory, smooth and spring pigweed, etc.) almost completely for more than six weeks; in fact, the plots were not cultivated or hoed at any time and yielded about 10 percent more seed cotton than the hoed and cultivated checks. The 2 gallon rate of Dow Selective gave adequate weed control to have eliminated the necessity of hoeing. The sodium salt of 2,4-D gave excellent annual weed control (2.6 and 5.2 pounds of 2,4-D per acre) but was very injurious to cotton. (Contributed by Mississippi Agricultural Experiment Station, Dept. of Plant Pathology and Physiology, and U. S. Department of Agriculture, Division of Cereal Crops and Diseases.)

REPORT OF THE SUBCOMMITTEE ON RESEARCH CONCERNING THE ERADICATION OF WOODY PLANTS

This report is a collection of abstracts and reports of susceptibility of woody plants to 2,4-dichlorophenoxyacetic acid and its various formulations, contributed by research workers in the United States and Canada.

The subcommittee wishes to express its appreciation to those workers whose contributions made this report possible, and to the E. I. duPont deNemours & Company, of Wilmington, Delaware, for furnishing the mimeographed copies.

Personnel of subcommittee: Keith Barrons, R. S. Dunham, A. H. Larson, L. M. Stahler, and L. W. Melander, Chairman.

FOREWORD

Noxious woody plants present a formidable problem in the United States. Millions of dollars are spent each year to eradicate woody plants on right-of-ways along highways, railroads, drainage ditches, and power lines. The livestock industry is forced to invest vast amounts of money for feed supplements because woody plants in many old permanent pastures reduce the amount of potential forage. Federal, State, and local agencies, and individuals utilize considerable labor and chemicals to eradicate woody alternate hosts of destructive plant diseases such as stem rust of grains, blister rust of white pine, and cedar rust of apples.

Up to recently, most of the clearing work along right-of-ways has been accomplished by using manual labor and some machines, which has made the cost almost prohibitive. It is encouraging to note that the attention now given to the efficacy of herbicides is causing more and more interest in improving and lowering the cost of eradicating woody plants. Obviously, a tremendous amount of research, both basic and empirical, is necessary before the desired efficiency can be obtained.

Progress is being made, but it is greatly limited by the lack of adequate support. Considerable credit is due State and Federal experiment workers for the work they are doing on woody shrubs. The results contained in the abstracts in this report demonstrate that these investigators are making progress in spite of the limited time and facilities available to them.

From the data available in this report, a few conclusions may be drawn.

Control of woody plants by various mechanical means.

In Oklahoma and other States, various types of machines have been built and used for eradicating woody plants on the range pastures. The following quotation from an abstract by Mr. D. A. Savage, of the U. S. Department of Agriculture and stationed at Woodward, Oklahoma, is significant: "Sagebrush was controlled to best advantage by mowing it in June for two successive years and keeping livestock off the range from June to fall of those years. These treatments eradicated many of the sagebrush plants.....The advantages in cattle gains the first two winters following the summers of mowing and grazing deferment was sufficient to defray the costs of the treatments....." This

lends encouragement for future investigations in controlling woody plants through mechanical means.

Efficiency of herbicides for killing woody plants.

The three types of herbicides which are receiving the most attention by investigators studying methods to control woody plants are: 2,4-dichlorophenoxyacetic acids combined with other chemicals to form salts and esters; other similar types of hormones such as 2,4,5-trichlorophenoxyacetic acid; and ammonium sulfamate. The preponderance of reports of investigations deals with the first of the above types of chemical. From the abstracts, you will note that most of the research was of the field experimental type and that there is a paucity of abstracts reporting results of basic research which obviously is needed to guide field experimentation. At the present time, the latter is hampered by lack of basic information concerning what actually happens when the various herbicides are applied to the plants in different dosages and under different conditions.

The data contained in the abstracts and the "susceptibility" table further confirm the fact that 2,4-D formulations are highly selective in their herbicidal effects. Therefore, when a complete kill is necessary, only susceptible species and varieties of plants should be recommended for treatment with 2,4-D by the general public. If only defoliation is desired, more extensive use of the chemical can be made.

In some instances where foliage sprays are ineffective, cutting the canes and trunks and applying the chemical to the cut surfaces of the stumps seem to give an effective kill. The reduction of the amount of surface to which the chemical can be applied probably necessitates the use of much higher concentration of the chemical. Some results have indicated that upward of 5 per cent solutions must be used. However, there are not sufficient data available to support a definite recommendation for the general use of this technique.

Cutting the bark and exposing the cambium so it can be treated furnish an avenue of entrance for herbicides, but the results reported are not consistent. Therefore, before any recommendations can be made, much more study must be given this method of chemical application.

The fact that 2,4,5-trichlorophenoxyacetic acid appears to kill some types of plants that are resistant to 2,4-D formulations lends hope that eventually there will be effective herbicides for every type of plant. It is hoped that further tests with 2,4,5-T will be reported at the 1948 conference.

Ammonium sulfamate has distinct herbicidal properties for killing some woody plants. Compared to 2,4-D, when used as a foliage spray, this chemical appears to be much more costly. However, when it is applied to cut surfaces of some shrub canes or to tree stumps, it appears to be very efficient in preventing sprouting as well as a good means of expediting the rotting and decomposition of the wood. The application of this chemical to the cut surfaces as a dry salt appears to be the most effective method. However, if a technique can be evolved where a highly concentrated solution may be used and an effective kill obtained, the cost of treatment will be greatly reduced. This chemical deserves considerable further study to improve its efficiency as well as to lower the cost of using it.

Combining mechanical and herbicidal methods of eradication.

Along right-of-ways of various kinds, it is necessary that the brush and trees be cleared away. These are much easier to cut off when green than when they are dead. Without subsequent treatments of the cut surfaces with effective herbicides, the regrowth develops almost immediately and sometimes it is more dense than the original growth. If an efficient application technique could be evolved and a good non-selective chemical that would kill the roots of the cut-off plants were found, a tremendous amount of regrowth would be prevented and the cost of right-of-ways maintenance would be drastically reduced. As already pointed out, some investigators have shown that 2,4-D formulations and ammonium sulfamate warrant further study for this type of use.

Progress is encouraging.

The data contained in the abstracts submitted by the various investigators show that considerable progress has been made in the chemical and mechanical phases of woody plant eradication. However, considering the magnitude of the problem, there is an obvious need for more basic research and experimentation, both with the herbicides and methods development if we are to have a sound program to recommend to the general public.

Subcommittee on eradication of woody plants
L. W. Melander, Chairman

ABSTRACTS

Submitted to
Subcommittee on Research
in Eradicating Woody Plants

North Central Weed Control Conference
1947

A comparison of several 2,4-D formulations when sprayed on poison ivy. Anderson, E. G. Several types of 2,4-D were sprayed on poison ivy during July and August, 1947, to compare their effectiveness when the manufacturer's recommendations, as to concentration, were followed. The plots were one square rod in area and each was sprayed with one gallon of solution by means of a knapsack sprayer. Between each operation the sprayer was rinsed first with a warm solution of sodium pyrophosphate and then with warm water. The following is the order of their effectiveness based on the percentage of observed defoliation: - butyl ester, ethyl ester, amine salt (liquid), amine salt (in carbowax) and sodium salt. This order of effectiveness was substantiated when the plots sprayed in 1946 were examined and observations made of the poison ivy killed. (Contributed by the Division of Botany and Plant Pathology, Science Service, Dominion Department of Agriculture, Ottawa, Canada.)

Field trials using 2,4-D for control of willows. Baranek, Paul P. Field trials, using 2,4-D compounds for controlling willows, have been carried on for two years in the Sacramanto-San Joaquin Delta, Sacramento. Work was con-

ducted on the sandbar willow (Salix sessilifolia) and yellow willow (Salix lasiandra) of all sizes and ages. In some trials they were cut to ground level in the pre-treatment stage. Regrowth was sprayed at a later date. Compounds used were sodium salt and a methyl ester of 2,4-D. With the sodium salt, 3 gallons of diesel oil per 100 gallons of water were always used. The concentration in all trials was approximately 2000 ppm. Pressures used varied from 75 to 500 pounds per square inch. Rate of application was 300 gallons per acre. The results are as follows: (1) Young willows (under 3 years) required up to two applications for a complete kill; (2) older willows (over 3 years) required three or more applications; in some cases, the control period extended into the second year; (3) not much difference was noted in the control of willows that were "cut" in comparison to those "uncut", although it was easier to get coverage on the regrowth of the "cut" willows using low pressures (75 to 150 pounds) than on the "uncut" ones; (4) no difference in results was obtained from using pressures of 75 pounds to 500 pounds. In general, better coverage was obtained on tall willows (over 15 feet high) using the higher pressure. (5) Results were the same, using either the sodium salt (with diesel) or methyl ester. (Contribution of Bureau of Reclamation, Region II, Delta District, Sacramento, California.)

A test of several solvents for the application of growth substance herbicides to bark and cut surfaces. Barrons, Keith C. and L. L. Coulter. The treatment of stumps and other cut surfaces with the growth-substance herbicides shows considerable promise as a means of eradicating woody plants. Treatment of uncut bark of young growth also has possibilities. For such applications petroleum oils have been used as solvents or carriers for the esters of 2,4-D. Presumably the oil aids in the penetration of the herbicides. The writers have used petroleum fractions and other organic chemicals as solvents for the esters of 2,4-D in comparative tests on elm stumps and uncut brush in order to determine whether differences exist in their usefulness as carriers. Stoddard Solvent, the lowest boiling petroleum fraction used, gave significantly poorer results than kerosene, No. 1 fuel oil or No. 3 fuel oil. Presumably the Stoddard Solvent tended to evaporate before an appreciable amount had penetrated to the growing tissues, thus leaving the ester of 2,4-D near the surface. These three cheap petroleum fractions gave as good if not better results than several more expensive organic solvents. Kerosene, the various fuel oils, and similar high boiling fractions are suggested as suitable carriers for the esters of the growth substance herbicides. (Contribution of the Dow Chemical Company, Midland, Michigan.)

Possibilities of controlling brush by dormant season applications of growth-substance herbicides. Barrons, Keith C. and Coulter, L. L. Applications of the isopropyl ester of 2,4-D at a concentration of 4000 ppm in fuel oil to the uncut bark of several species of vines and woody brush during the dormant season resulted in a good kill of top growth in many instances. Tests were insufficient to accurately evaluate root kill compared with other methods of application. Treatments were made by thoroughly spraying the bark from the ground to the 2-3 foot level using a knapsack sprayer. Applications to elm of various sizes indicated that a kill cannot be expected after mature corky bark has developed. The possible value of a dormant season treatment can well be appreciated when one considers the widespread occurrence of brush in pastures, fence rows, ditches, and elsewhere on the average farm where frequently too little time is available for control measures during the growing season. Much experimental work will be required before dormant season applications of the growth

regulating substances in oil to the uncut bark of woody plants can be recommended. In making tests the factors of species response to different chemicals, maturity of wood, season of application and volume and concentration requirements should be taken into consideration. (Contribution of the Dow Chemical Company, Midland, Michigan.)

The specific effect of 2,4,5-trichlorophenoxyacetic acid on members of the genus Rubus and certain other 2,4-D resistant species. Barrons, Keith C. and Coulter, L.L. The members of the genus Rubus commonly called the brambles, i.e. the raspberries, blackberries and dewberries, have been found to be highly resistant to 2,4-D. The widespread occurrence of these species as an undesirable component of pasture, orchard, and right-of-way vegetation led the writers to undertake a search for a more effective chemical of the growth substance type. The isopropyl ester of 2,4,5-trichlorophenoxyacetic acid proved very effective on the four members of this genus with which tests were conducted. Mixtures of this chemical with the isopropyl ester of 2,4-D applied to mixed woody vegetation gave good control of many species including those of the genus Rubus. Herbaceous species which have been found to be susceptible to this chemical while quite resistant to the various formulations of 2,4-D are strawberry, ground cherry and the common potato. Apparent although less conclusive differences in favor of 2,4,5-trichlorophenoxyacetic acid were noted in the case of one species of rose, two hawthorns, and osage orange. This chemical should be widely tested in 1948 on species that are resistant or partially resistant to 2,4-D. (Contribution of the Dow Chemical Company, Midland, Michigan.)

Treatment of willows with 2,4-D. Bower, Walter. Definite results were obtained on willows with 2,4-D on the Klamath Project during 1947. The following examples of treatment are representative of those made on this project:

a. On August 7, 1947, applied Dow Esteron 44 on 30 square rods of of willows on the F-1 lateral. Mixture 2 lbs. material containing .8 lb. parent acid to 100 gallons of water, applied at the rate of 1.2 gallons per square rod. Willows 5 to 10 feet high. Inspection on October 23, 1947, indicates a 100 per cent kill of current season growth.

b. On August 11, 1947, applied Dow Esteron 44 on 125 square rods of willows on the C-5 lateral. Mixture 2 lbs. material containing .8 lb. parent acid to 100 gallons of water, applied at the rate of 1.6 gallons per square rod. Willows 2 to 10 feet high. Inspection of October 23, 1947, indicates approximately a 95 percent kill of current season growth with a few live sprouts showing up.

c. On May 15, 1947, applied Chipmans 60% 2,4-D (Powder form) on 70 square rods of willows on the "B" canal. Mixture 2 lbs. material containing 1.2 lbs. parent acid to 100 gallons of water applied at the rate of 1.4 gallons per square rod. Willows 5 to 15 feet high. Inspection on October 23, 1947, indicates approximately a 90 percent kill of current season growth with several new sprouts in evidence. (Contribution of U. S. Bureau of Reclamation, Region II, Klamath District, Klamath Falls, Oregon.)

Killing arroyo Willows with herbicides. Bruns, V. F. Arroyo willows (Salix lasiolepis) growing on the shoulders of an oil-surfaced road adjacent to a small irrigation ditch near Prosser, Washington were treated with the butyl ester of 2,4-D (2,4-Dichlorophenoxyacetic acid) on July 1, 1947, when the trees were growing actively and averaged 6 feet in height. The rates of application were 2/3, 1-1/4, 2, and 2-2/3 pounds per acre (acid basis). Two weeks after treatment all leaf growth was dead, even on plots receiving the lightest application. Eight weeks following treatment most of the original above-ground stems and branches were dead, but considerable regrowth had occurred from underground portions as well as from portions of the more mature stems as high as 18 inches above ground. Also, new shoots had emerged in abundance through the oil mat of the roadway for a distance of two to three feet from the road-shoulder and the original willow top-growth. Percentage survival and/or regrowth, as compared with untreated growth, averaged 27.5, 12.5, 3.5, and 3.5 for the 2/3, 1-1/4, 2, and 2-2/3 pounds per acre treatments, respectively. (Contribution of the U. S. Department of Agriculture, Bureau of Plant Industry, Soils, and Agricultural Engineering, Division of Cereal Crops and Diseases, cooperating with the Irrigation Branch Experiment Station, Prosser, Washington.)

Killing European barberry (Berberis vulgaris) with ammonium sulfamate applied as a dry salt to the cut surfaces of canes. Busdicker, H. B., G. W. Eade, and L. W. Melander. Ammonium sulfamate applied to cut surfaces of the canes at the ground level December 5, 1944, killed 467 (B. vulgaris) bushes near Spokane, Washington. An average rate of .32 pounds of the amate per bush was used. To protect the chemical from the elements, the crowns of the bushes were covered with soil. Subsequently, numerous bushes in the States of Washington, Minnesota, Wisconsin, Illinois, Pennsylvania, and Ohio have been treated at all seasons of the year with highly satisfactory results. This method of eradicating (B. vulgaris) is now a recommended practice for treating escape bushes. In 1942, ammonium sulfamate applied both as a foliage spray and as a crown drench to (B. vulgaris) bushes in Pennsylvania did not give satisfactory results. (Contribution of Division of Plt. Dis. Cont., Bur. of Ent. & Plt. Quar., USDA; and Div. of Hort., Wash. State Dept. of Agr.)

The use of dinitro phenol for the control of aspen. Day, Maurice W. Aspen is a problem species on millions of acres of lighter soils in the Lake States. In the past the three principal methods of controlling aspen have been cutting, girdling and poisoning with sodium arsenite. Each method has disadvantages and it appears that spraying the trunks with an oil solution of dinitro ortho secondary butyl phenol may offer several advantages. Tests at the Dunbar Forest Experiment Station over a period of three years have shown that the method gives consistent results. A solution supplied by the Dow Chemical Company under the code number G414 when used at a concentration of .05 pounds of the toxicant per gallon of kerosene or fuel oil gave the best results. Stems up to 3 inches in diameter were completely killed in practically all cases. Larger stems were more resistant and trees over 6 inches in diameter were seldom killed. Sprouts or root suckers did not appear. Tests this year with other solutions at lower concentrations and in water instead of oil did not give satisfactory results. (Abstract of article to appear in November issue Mich. Agr. Expt. Sta. Quarterly Bulletin.) (Contribution of Michigan State College-Forest Experiment Station.)

The control of certain shrubs in the Lake States. Day, Maurice W. A study of the control of hazel (Corylus sornuta), chokecherry (Prunus virginiana), pin cherry (Prunus pennsylvanica), mountain maple (Acer spicatum), alder (Alnus incana), and willow (Salix sp). Chemical, mechanical and silvicultural control are considered. Experiments indicated ammonium sulphamate was most effective on hazel, but other species sprouted strongly following treatment. Sodium arsenite was effective but difficult to apply and excessively dangerous. Sprays containing 2,4-D were most effective on hazel and least on mountain maple. Oil solutions were superior to aqueous solutions. 2,4-D was most effective in preventing sprouting and was the most promising substance tried for all species except mountain maple. Of the mechanical methods the use of heavy tractors and discs gave the most promise. Silvicultural control was based on the maintenance of fully stocked stands reproduced before reaching overmaturity. (Contribution of Michigan State College-Forest Experiment Station.)

Ammate for the control of oak brush. 1/ Elwell, Harry M. 2/Ammate spray (one pound per gallon of water) applied during the rapid growing period has given good defoliation of scrubby oaks commonly found in cross-timbered areas of Oklahoma. Best results were obtained when the solution was applied at a pressure under 100 pounds and by thoroughly saturating the leaf surface. Some of the plants produced new rosettes of leaves along the main branches and stems in three to six weeks after the initial treatment. A second and sometimes a third application was necessary to completely eradicate the regrowth. The Ammate solution also burned the native grasses often found intermingled in the brush. However, areas that were sprayed three years ago are now producing a good-to-excellent stand of bluestem, switch and Indian grass. There is only a trace of sprout growth left at the present time where once over twenty thousand brushy plants per acre occupied the land.

1/ Cooperative contribution for the Oklahoma Agricultural Experiment Station and Soil Conservation Research. Abstract taken from Preliminary Report of Chemicals for Brush Control, Oklahoma Agricultural Experiment Station Mimeographed Circular M-164.

2/ Soil Conservationist, Red Plains Conservation Experiment Station, Guthrie, Oklahoma.

Brush Control with 2,4-D. 1/Elwell, Harry M.2/ Tests with 2,4-D were conducted at the Red Plains Conservation Experiment Station in 1945, 46, and 47, and in field trial studies in Comanche, Pottawatomie, Johnston, Adair, and Rogers Counties soil conservation districts. For complete removal of the leaves and foliage, they must be uniformly covered with the spray solution. A rather coarse mist, at 100 to 150 pounds pressure, applied at 2,000 P.P.M. during the rapid growing period gave best results. The 2,4-D sprays are more readily effective on brush or trees from 3 to 4 feet high. There were seventeen species of brush and trees in the areas treated. Plants 80 to 95 percent affected by one application of 2,4-D were sumac, sand plum, black and honey locust, persimmon and sassafras. Those 50 to 75 percent affected were black-jack, post and dwarf chinquapin oaks, also willow. But American and winged elms, mesquite, hackberry, hickory, bois d-arc and red cedar were not affected by 2,4-D sprays in the 1946-47 tests. The 2,4-D did not affect the native grasses in any of the tests. But this material is toxic to legumes, cotton, vegetables, and many other plants. Therefore, extreme caution should be used when applying it near such plants.

1/ Cooperative contribution for the Oklahoma Agricultural Experiment Station and Soil Conservation Research. Abstract taken from Preliminary Report of Chemicals for Brush Control, Oklahoma Agricultural Experiment Station Mimeographed Circular M-164.
2/ Soil Conservationist, Red Plains Conservation Experiment Station, Guthrie, Oklahoma.)

Willow control with 2,4-D. Erickson, Lambert C. Trial plots to determine the value of 2,4-D for the control of willows were started in the fall of 1945 on the Black Canyon Reclamation Project, Notis, Idaho. Similar duplicate treatments were made again in the spring, summer, and fall of 1946. Materials used were: Sodium salt, triethylamine salt, and acid-carbowax 2,4-D. Treatment rates were equivalent to: 0.5, 1.0, 2.0, and 4.0 pounds of 2,4-D acid per acre. The amount of regrowth of willows recurring on these plots as a result of one treatment were made on or about June 1, 1946 and 1947, on the 1945 and 1946 treatments, respectively. Regrowth recurring as an average for all these materials as compared with the original stand was 47%, 29%, 18% and 9% for the 0.5, 1.0, 2.0, and 4.0 pound rates per acre respectively. Summer and fall treatments, in general, gave more efficient results than early spring treatments. Two pounds per acre was deemed the most efficient rate. Using these results as a basis for control work, this Reclamation Project treated 43 miles of irrigation ditch banks in 1946, and 69 miles in 1947, all at the equivalent of 2 pounds of the parent acid per acre. (Contribution of the Idaho Agricultural Experiment Station, Moscow, Idaho.)

Present Information on the Mesquite Problem. Fisher, C. E., Agronomist, Sub-station No. 7, Spur, Texas. Progress Report 1056. Texas Agricultural Experiment Station. February 13, 1947. The fundamental principle in mesquite eradication is to kill the dormant sprout buds on the underground stem. Fire, frost, browsing or other means that kill only the topwood bring about sprouting from the underground stem and growth that is more objectionable than original trees. Methods of eradicating mesquite include oils, sodium arsenite, hand and power grubbing, tree saw and sprout control. Growth habit, stands, soil texture and moisture content and size of unit are factors that determine the effectiveness and cost of method selected. Control of seedlings, effect of shade on yield and quality of summer grasses, grazing trials on cleared and uncleared pastures and methods of preparing sodium arsenite solutions are also discussed.

Factors Affecting Action of Oils and Water Soluble Chemicals in Mesquite Eradication. Fisher, C. E., Jess L. Fultz and Henry Hopp.* Ecological Monographs 16: 109-126, April 1946. Morphological studies showed that dormant buds on the underground stem of mesquite, a sprouting shrub, must be destroyed either chemically or mechanically to kill the plant. Sodium arsenite, a systemic poison, was the most effective and economical chemical tested when application was made to sapwood of stumps. Other systemic chemicals tested were sodium arsenite, sodium chlorate, ammonium thio-cyanate, ammonium sulfamate, sulfamic acid and zinc chloride. Sodium arsenite introduced into the sapwood moved through the vascular system longitudinally with little or no tangential movement. Extent of penetration of sodium arsenite in plant tissue was directly related to length of time it remained in moist contact with sapwood. Oils such as kerosene, diesel fuels and other similar petroleum products were effective when placed in direct physical contact with dormant sprout buds on the underground stem. The volume of oils necessary to kill mesquite was influenced by growth forms, method of application and soil factors of texture and

moisture. *(Agronomist, Associate Agronomist and Soil Conservationist respectively of the Texas Agricultural Experiment Station; the Amarillo Conservation Experiment Station, Soil Conservation Service, Amarillo, Texas; and the Erosion Control Practices Division, Soil Conservation Service, Beltsville, Maryland.)

Effect of foliage sprays on 2,4-D on woody plants when applied to nearby herbaceous plants. Friesen, H. A. Experiments were conducted with the object of determining whether weeds growing under shrubbery such as honeysuckle, lilac and carrigana could be eradicated by means of 2,4-D without injury to the shrubs. The sodium salt and ester types of 2,4-D were sprayed on and around the bases of the above shrubs at concentration of eight and sixteen ounces per acre. Lilac leaves and suckers which come in actual contact with the spray were halted in their growth. The leaves were much thickened and deformed but did not wither and die until early fall. Carrigana shrubs showed a similar reaction except that the leaves dropped off much sooner, in midsummer. The untouched portions of the shrubs appeared to show no ill effect. The honeysuckle bushes treated were tall and had no suckers. Consequently, the foliage was not touched. Until the time of writing these bushes have shown no ill effects either from the 2,4-D spray, which struck the bark at the base, or from the volatile 2,4-D in the air. (Contribution of Dominion Experimental Station, Scott, Sask.)

Effect of 2,4-D on Western snowberry. Friesen, H. A. Western snowberry was treated with eight, sixteen and thirty-two ounces of the butyl ester type of 2,4-D. Two treatments were made, one in May and one in July. The two heavy rates caused considerable defoliation in the May treatment but little effect was observed after the July treatment. (Contribution of Dominion Experimental Station, Scott, Sask.)

Killing of woody plants with herbicides. Garmhausen, W. J. Herbicides used by the Ohio Department of Highways for the control of woody plants growing in the ditches within our Right of Way has been very limited. The one section that was treated with a 2,4-D ester was sprayed in midsummer and the type of growth was Maple, Elm, Poplar and Hackberry. These plants were given a thorough application and the results were very good in that within a period of two months the plants were dead and no regrowth had occurred. What the results will be in this area within a year we can only guess. However, we will have no regrowth from the sprayed plants as a few species examined showed the roots to be disintegrating. It would seem therefore that any recurrence of growth in these ditch areas will only result from seed germination. In this event these seedlings will be easily eliminated by an application early in the spring. (Contribution of Ohio Department of Highways, Roadside Improvement, Columbus 15, Ohio.)

Killing of woody plants with herbicides. Garmhausen, W. J. The use of herbicide for the control of woody plants within our highway Right of Way is still only an experiment with the Ohio Department of Highways. We have treated sections where sight distance was limited and the trees had grown to a height where only the elimination of the lower branches was necessary. In one section the following species of trees were treated with a 2,4-D ester in late June. They were Willow, Poplar, Sycamore and Honey Locust. The lower branches were sprayed up to a height of ten feet above the ground and the results on the Willows, Poplars, and Sycamores were that the leaves died within a period of a month and the branches within a few months. There was no resprouting on the Poplar and Sycamore by late summer but the Honey Locust showed no effects whatsoever at any time. In another section where the objective again was to increase

the sight distance most of the material was low growing shrubs such as witch hazel, spice bush and sumac. The remainder was regrowth consisting of Elm, Sycamore and Poplar. The herbicide used was a 2,4-D ester again and the application was also made in the early summer. The results by late summer were that where the materials were thoroughly and entirely sprayed the plants were completely dead. (Contribution of Ohio Department of Highways, Roadside Improvement, Columbus 15, Ohio.)

Effect of treatments with ammonium sulfamate and sodium chlorate on stumps of cottonwood (Populus deltoides). Hanson, Noel S.1/ A series of cottonwood stumps ranging from 24 to 36 inches in diameter were treated with ammonium sulfamate (Ammate) on March 15, 1947, after the trees had been cut in November of 1946. Four methods of application of the ammonium sulfamate and one method with sodium chlorate were used. (1) Cambium treatment in 1/2-inch holes 8 inches apart and 4 inches deep. Approximately one pound per stump. (2) Same as (1) except size of holes 3/4 inch and approximately 1-1/2 pounds per stump applied. (3) Approximately 2 pounds per stump as dry cambium treatment over top of entire cambial ring. (4) Same as (3) except that the chemical was dissolved to a concentrated solution and poured over the cambial ring. (5) No treatment. Two stumps were treated by each method. One stump was treated with sodium chlorate according to method (3). This stump was burned 10 days after treatment. Observations on October 15, 1947, showed the following: (1) One cambium sprout on each stump, two root sprouts on one, and none on the other. All sprouts 4 feet tall. (2) No cambium sprouts on either stump. Three root sprouts 5 feet tall on one and one sprout one foot tall on the other. (3) Both stumps dead. (4) No cambium sprouts, but two root sprouts 2 and 4 feet tall on each. (5) Untreated stump with two and five cambial sprouts and two and one root sprout 3 and 6 feet tall. The sodium chlorate treated stump was dead.
1/ Assistant Agronomist, Nebraska Experiment Station, Lincoln, Nebraska.)

Effect of 2,4-D spray on black walnut trees. Hanson, Noel S.1/ At Lincoln Nebraska, a row of black walnut trees was damaged by drifitng 2,4-D spray applied experimentally by airplane to a field of oats. The type 2,4-D applied was butyl ester at dosages of 1/4 and 1/2 pounds per acre in 2 gallons diesel fuel. The trees were in full leaf and buds were present at the time. During one flight the wind velocity was approximately 5 to 8 miles per hour directly toward the trees. Glass plates laid out in the oat field intercepted 50 to 65 droplets per square inch. Glass plates placed near the walnut trees intercepted 25 droplets per square inch. No drift was intercepted near the trees during the other flights. Thirty hours after treatment leaves on the sprayed side were drooped. Twigs showed typical 2,4-D curvature. Two weeks after treatment a differential leaf coloring between trees was noticed indicating differential tolerance. A few trees showed little effect of the spray and leaves were green. Other trees had yellow leaves on one side. Some trees had yellow leaves throughout. Later observations showed that the nut crop was almost eliminated. Nuts were produced only on trees that earlier had shown the greater tolerance. Defoliation and twig damage was in proportion to the earlier leaf color effect, varying from approximately 90 per cent to less than 5 per cent defoliation. No tree was completely killed.
(1/ Assistant Agronomist, Nebraska Experiment Station, Lincoln, Nebraska.)

Field trials with 2,4-D for control of poison oak. Koehler, James W. Definite results were obtained in field trials in the Shasta Lake area using

the butyl esters of 2,4-D mixed with diesel oil for the control of poison oak. An estimated ten acres of poison oak with an average density of 25% was sprayed with a low volume concentration of the butyl ester of 2,4-D mixed with diesel oil during the first week of July 1947. The commercial product tested was Weed-no-More 50 in a concentration of one part commercial product to twenty parts diesel oil at an average rate of application of 25 gallons per acre. Complete coverage of the foliage was attempted without causing run-off of the spray material. Material was applied with power spray equipment at a pressure of 30 pounds per square inch. The maximum termperature during spraying was 93 degrees F with a clear sky, and a light breeze. Observations made at intervals during the months of July, August and September indicate that a good top and crown kill was obtained on about 80 percent of the plants. No regrowth had started at the time of the last observation in September. (Contribution of the Bureau of Reclamation, Region II, Sacramento Valley District, Chico, California.)

Effect of foliage sprays with various 2,4-dichlorophenoxyacetic acid formulations on native barberries (Berberis canadensis Mill. and B. fendleri Gray). Melander, L. W., E. A. Lungren, and W. M. Watson. During 1946 foliage sprays of various formulations of 2,4-dichlorophenoxyacetic acid in concentrations of 500, 1,000, 1,500, and 2,000 ppm were applied to quarter-square-rod plots of B. canadensis in West Virginia and B. fendleri in Colorado. Three applications were made: one in early summer, one in midsummer, and one in September. The 2,4-D formulations had little or no effect on B. canadensis, while B. fendleri seemed relatively susceptible to this herbicide. The ammonium and triethanolamine salts of 2,4-D killed the latter species of barberry in most cases; however, methyl ester of 2,4-D seemed to be the most consistently effective. Concentrations of 2,000 ppm were the most effective on this species of woody plants. The best "kills" were obtained from the midsummer treatments, and the fall treatments were the least effective. The midsummer applications of 2,4-D appear to be as effective as the chlorate (Atlacide) checks. These results are based on only one year's tests. A similar series was run in 1947, but the results will not be available until 1948. (Contribution of Div. of Plt. Dis. Contr., Bur. of Ent. & Plt. Quar., USDA.)

Effect of various concentrated 2,4-D formulations when applied to cut surfaces of the canes of European barberry (Berberis vulgaris). Melander, L. W. In the fall of 1945, triethanolamine salt of 2,4-dichlorophenoxyacetic acid applied as a 30 per cent solution to the cut surfaces of the canes killed five large barberry bushes (B. vulgaris) in Minnesota. Uniform lethal results with salts and esters of 2,4-D applied to cut surfaces of barberries have been obtained in the greenhouse; however, field tests with different concentrations of this chemical in several states have shown that, while a high percentage of the bushes are killed by this method, there still is some sprouting. Where sprouting occurred, there were indications that the concentration of the chemical was not sufficient or that the method of treatment was faulty. Further study is being made to improve the methods used in applying 2,4-D formulations to the cut surfaces of barberry canes and to determine the most effective concentration of the chemical. (Contribution of Div. of Plt. Dis. Cont., Bur. of Ent. & Plt. Quar., USDA.)

Killing salt cedar (Tamarix gallica) with herbicides. Mercer, William H. Definite results were obtained with 2,4-D ester, 1000 ppm, in water solution applied as spray on foliage, when growth did not exceed 1" diameter or approximately two years' growth. Older and larger growth was defoliated but the root

system was not seriously affected. Best results were obtained when the spray was applied on young growth of the current season. Experimental work was done on Bureau of Reclamation Irrigation Projects at Tucumcari, New Mexico, and El Paso, Texas. (Contribution of the Bureau of Reclamation, Region 5, Amarillo, Texas.)

Killing willows (Salix sp.) with herbicides. Mercer, William H. Definite results were obtained with 2,4-D, DuPont I, N.6065, 1000 ppm, in water solution, applied as spray on foliage. Equal success was obtained on growth of current season 2' high, and on growth of previous season plus the current season's growth 4' to 6' high. This experimental work was done on canal banks of the Bureau of Reclamation Irrigation Project at El Paso, Texas, in May 1944. There has been practically no regrowth. (Contribution of the Bureau of Reclamation, Region 5, Amarillo, Texas.)

The best time of year to apply herbicides for the eradication of poison ivy. Minshall, Wm. Harold. At Ottawa, Canada, in each of the months of June, July, August, and September, 1946, one gallon of 1000 ppm solution of 2,4-D acid with carbowax and 2,4-D triethanolamine salt, calculated on the basis of weight, and one gallon of 10% ammonium sulfamate were applied, with a knapsack sprayer, to plots, 100 square feet in area, containing approximately an 85% stand of poison ivy. The percentage reduction in poison ivy in July 1947 for the June 13, July 16, August 14, and September 12 treatments respectively were: for 2,4-D acid with carbowax 80%, 6%, and 7%; for 2,4-D triethanolamine salt 78%, 6%, 5% and 6%; and for ammonium sulfamate 98%, 90%, 47% and 17%. The applications made in June, when the plants are in flower, gave by far the best control of poison ivy for all three materials. The July, August, and September treatments with 2,4-D acid and its triethanolamine salt and the September application with ammonium sulfamate had very little effect on the stand of poison ivy. In general, the results obtained from these tests made in 1946 corroborate those from the 1945 treatments in that applications in June produced the best control of poison ivy. However, variations in results were evident for the different materials and, on the basis of present information, it would appear as if the control from June applications with certain 2,4-D formulations is not as consistent as with that from ammonium sulfamate. (Contribution of the Division of Botany and Plant Pathology, Science Service, Dominion Department of Agriculture, Ottawa, Ontario, Canada.)

The effect of cutting prior to treatment on the eradication of poison ivy with herbicides. Minshall, Wm. Harold. In an area with an approximately 80% stand of poison ivy, all top growth was removed, with a sickle, from certain plots in the month of June for three consecutive years. Other plots were not cut. In the month of July applications of 10% ammonium sulfamate and of 1000 ppm 2,4-D acid, with carbowax as cosolvent, were made to normal uncut plots, to plots cut in June of the current year, and to plots cut in June of the previous year. With the 2,4-D the best control was obtained on the plots from which all top growth was removed in the current year and the poorest control from the normal uncut plots. Those plots from which top growth was removed in the year previous to treatment were intermediate. With ammonium sulfamate removal of top growth prior to treatment gave the best control with the 1945 applications but with those made in 1946 the results were approximately the same for the normal uncut plots and those cut prior to treatment. Although the results with ammonium sulfamate have not been as consistent as with 2,4-D, in no case has the removal of top growth prior to spraying been detrimental as regards

control from these July applications. The experiment is still in progress. (Contribution of the Division of Botany and Plant Pathology, Science Service, Dominion Department of Agriculture, Ottawa, Ontario, Canada.)

A comparison of 2,4-Dichlorophenoxyacetic acid formulations with ammonium sulfamate and sodium chlorate as eradicants for poison ivy. Minshall, Wm. Harold. At Ottawa, Canada, one gallon of 500, 1000 and 2000 ppm concentration of four 2,4-D formulations, calculated on the basis of weight, were applied on June 19, 1946, to plots, 100 square feet in area, containing approximately in 85% stand for poison ivy. For comparison, applications of one pound per gallon of ammonium sulfamate and sodium chlorate were included in the experiment. The percentage reduction in poison ivy in July, 1947, for the respective applications of 1000 ppm 2,4-D and the 10% ammonium sulfamate and sodium chlorate were: 2,4-D methyl ester 98%, 2,4-D acid with carbowax 67%, 2,4-D ammonium salt 50%, 2,4-D triethanolamine salt 24%, ammonium sulfamate 98%, and sodium chlorate 88%. There was considerable variation in the effect of the different 2,4-D formulations on poison ivy. The control obtained from the methyl ester of 2,4-D was equal to that from ammonium sulfamate and better than that from sodium chlorate. Increasing the concentration of the 2,4-D formulations increased the control of poison ivy, but not on a proportional basis. The control of poison ivy obtained from these treatments made in 1946 was inferior for the 2,4-D acid, and 2,4-D ammonium salt but somewhat superior for the ammonium sulfamate and sodium chlorate to that from similar applications made on approximately the same date in 1945. The 2,4-D methyl ester was not applied in 1945. (Contribution of the Division of Botany and Plant Pathology, Science Service, Dominion Department of Agriculture, Ottawa, Ontario, Canada.)

2,4,5-trichlorophenoxyacetic acid as a weed killer. Neville, Homer B. and C. J. Willard. The butyl ester of 2,4,5-trichlorophenoxyacetic acid was compared with the butyl ester of 2,4-D in a small number of trials. Blackberry bushes, both old and new canes, were treated at 4 pounds of acid per acre. 2,4,5-T killed all top growth while 2,4-D killed only about 50% of the top growth. Cottonwood (Populus deltoides) has been rather resistant to 2,4-D formulations but the foliage was readily killed by 2,4,5-T. Cattails in water were treated with 2,4,5-T. at the rate of 8 pounds of acid per acre. The top growth was completely killed. Cattails have been quite resistant to 2,4-D. There has not been time to determine regrowth of any of these plants but the material is worth further study. (Contribution of Ohio Agricultural Experiment Station in cooperation with the Sherwin-Williams Company.)

Chemical eradication of Ribes. Offord, H. R. Since 1929, substantial economies have been made in Ribes eradication for white pine blister rust control by using chemicals for killing Ribes on sites where eradication by pulling or grubbing has been troublesome and costly. Methods and chemicals of greatest practical import have been: (1) Spraying the foliage and stems of intact Ribes with aqueous sodium Chlorate (1 to 1.5 lbs. per gallon of water), ammonium sulfamate ($\frac{1}{2}$ to 1 lb. per gallon of water), or 2,4-dichlorophenoxyacetic acid (750 ppm). (2) Decapitating the Ribes at or close to ground level and applying liquid or solid chemical directly to the freshly scarified crown or stub ends of stems. Liquids used have been Diesel oil, saturated aqueous ammonium sulfamate, and concentrates (1 to 20%) of 2,4-D (either an ester of 2,4-D in kerosene or Diesel oil, or an aqueous amine salt). (3) Spraying or wetting the intact basal stems with a light penetratin oil (kerosene) contain-

ing from 1 to 20% by weight of an ester of 2,4-D. Method (3) has been successful on small test plots but has not yet been used on an extensive scale. (Contribution of Bureau of Entomology and Plant Quarantine, Division of Plant Disease Control, Berkeley, California).

Testing of 2,4-D compounds for killing Ribes. Offord, H. R. Field tests (1945-47), and large-scale practical use (1947) of 2,4-D compounds for Ribes eradication have shown that: (1) Of the 27 Ribes species on which tests were made, only 7 (R. americanum, R. bracteosum, R. cereum, R. nevadense, R. petiolare, R. roezli, and R. speciosum) can be effectively and economically killed by dilute sprays applied to aerial plant parts. (2) Highly susceptible Ribes are not killed by dilute sprays unless all stems and leaves are thoroughly covered. (3) Effective work even on highly susceptible species can be done only during a relatively short period of the year. For mature bushes of most Ribes species this period corresponds to the interval between the start of vegetative growth (leaves fully expanded) and the time that fruits are about two-thirds size. (4) Ease of killing plants of a susceptible species varies with age, growth rate, and vigor. Old, slow-growing plants are the hardest to kill and have a shorter period of susceptibility during any one growing season than young, fast-growing plants. (5) Titanium dioxide, a brilliant white pigment (commercial grade known as Titanox B-30) is used as a marker at the rate of 1 to 1½ pounds per 100 gallons of 2,4-D spray solution. (6) Sodium, ammonium, and amine salts, and the several commonly available esters of 2,4-D are about equally effective on Ribes if comparisons are made on the acid equivalent basis. (7) All species of Ribes can be killed by applying concentrates of 2,4-D (1 to 20%) directly to the freshly exposed crown of decapitated plants. (Contribution of Bureau of Entomology and Plant Quarantine, Division of Plant Disease Control, Berkeley, California.)

Studies in mechanical treatment for control of woody plants. Savage, D. A. Ordinary heavy-duty power take-off mowers, equipped with snub-nosed guards for heavy brush or rock guards for medium-heavy brush, heavy underserrated sections, and a complete set of hold-down clips, have been effective in cutting most local types of brush when operated in low gear the first year and in ordinary gear but the opposite direction the second year. Discing, railing, or rolling have been less effective than the mower in cutting the surface growth of brush. Brush beaters remove the surface growth more completely than the mower but are more difficult to keep in working order. Sagebrush was controlled to best advantage by mowing it in June for two successive years and keeping livestock off the range from June to fall of those years. These treatments eradicated many of the sagebrush plants, reduced the vigor of the remaining shrubs, controlled many of the weeds, and greatly improved the vigor, density, and production of range grasses. (Contribution of the Division of Forage Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Woodward, Oklahoma.)

Grazing results in brush control. Savage, D. A. The effect of mowing sagebrush on beef production has been studied in duplicate mowed and nonmowed pastures grazed during the growing season and on similar pastures grazed throughout the year. The advantages in cattle gains the first two winters following the summers of mowing and grazing deferment were sufficient to defray the costs of the treatments. After that the advantages were clear profit and amounted to increases of 60 to 70 percent in carrying capacity, 10 to 16 percent in gain per head, and 80 to 91 percent in gain per acre. The actual increases due to

mowing ranged from 45 to 48 head of cattle in carrying capacity per section (640 acres), 29 to 47 pounds in gain per head, and 32 to 38 pounds in gain per acre, depending on whether the pastures were grazed during the growing season or on a year-long basis. (Contribution of the Division of Forage Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Woodward, Oklahoma.)

Study of root reserves in brush. Savage, D. A. Chemical analyses conducted through the cooperation of Dr. J. E. Webster of the Oklahoma Agricultural Experiment Station revealed that sagebrush roots contain the least quantity of carbohydrates and other food constituents in June and, therefore, can be controlled most effectively by mechanical treatment at that time. The low point of food storage in the roots of other plants occurred in May for skunkbush, on April 1 and June 1 for pricklypear, and on May 15 for shinnery-oak. The root reserve studies also have an important bearing on the proper time to control shrubs by spraying with 2,4-D. All of the shrubs grow actively for a month or so before the roots reach the minimum point of carbohydrate storage. (Contribution of the Division of Forage Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Woodward, Oklahoma.)

Use of 2,4-D in brush control. Savage, D. A. Excellent results in the control of sagebrush, skunkbush, sandplum, and many weeds were obtained in preliminary tests with various types of 2,4-D chemicals in 1946 and in extensive tests in 1947. The differential tests with various combinations of 2,4-D during the current year were conducted on 1,000 acres of range land in the Texas Panhandle and on 500 acres of land near Woodward. These studies were conducted through the cooperation of ten chemical companies, an airplane-spraying company, and local stockmen. The work was done by both air and ground-spray equipment. These and other range studies were under the immediate supervision of E. H. McIlvain of the Forage Division who is now completing graduate work at Utah State College. The treatment that seemed to be most effective in eradicating ~~the three plants mentioned~~ above consisted of applying 1 pound of 2,4-D acid, 0.6 pound of sodium carbonate, 1 gallon of diesel oil, and 4 gallons of water to the acre with an airplane. This home-made mixture, devised by J. R. Harlan of the Forage Division, represents the first of its kind used in brush-control work and was much cheaper and more effective than any commercial formula tested. The most effective time of control appeared to extend from about April 15 to June 1. One treatment during this period resulted in much more effective and cheaper control than was accomplished from three successive annual mowings. Stockmen of the region are now arranging with an airplane spraying company to apply these results on an extensive scale in 1948. The spraying company agrees to furnish, mix, and apply the materials in the proportions and at the rate listed above, at a cost of $2.00 an acre. None of the chemical treatments tested to date gave satisfactory control of shinnery-oak. A home-made preparation, consisting of 1 pound of 2,4-D acid, 3 pints of automobile antifreeze (methanol base), and 13 pints diesel oil to make 2 gallons per acre, appeared to give about as good control as commercial esters costing five to ten times as much. There was a considerable difference between brands of methanol antifreeze; however, one brand caused severe crystalization on the nozzles and precipitation in the mixing tank. (Contribution of the Division of Forage Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Woodward, Oklahoma.)

Killing brush on cut-over land in northern Minnesota. Schantz-Hansen, T. and Raymond A. Jensen. About two acres of a brushy forest tract were sprayed in August 1946, using 2,4-D (23.3 percent triethanolamine salt) at the rate of 1¼ pounds per 100 gallons of water. The area sprayed had a dense stand of hazel, alder, raspberry, cherry and some aspen with a scattering of conifers planted in 1946. The action of the chemical was evident by late August. A check of the area in July 1947 showed almost a complete kill of hazel, though there was some sprouting from stubs made during logging. Alder was completely killed except where spraying was incomplete. Raspberry showed no effect of the herbicide. Cherry was completely killed. Aspen was not affected when it was above the general level of the brush canopy. Scattered conifers, white pine and white spruce, planted ten years previously and now from two feet to three feet in height were not affected. Whether this was because they were protected from the spray by the brush or were resistant is difficult to determine without further trials. In 1947, an additional four acres was sprayed using the same 2,4-D preparation as in 1946, and a second 2,4-D preparation (44 percent isopropyl ester of 2,4-D) at the rate of one quart per 100 gallons of water. A spray adjuvant, I.P.C. Emulsion #272, was added to the herbicides. Results of the 1947 spraying will not be apparent until 1948. (Contribution of the Cloquet Forest Experiment Station, Division of Forestry, University of Minnesota.)

Control of willows with 2,4-D. Scott, H. Clay. Definite results were obtained with the use of 2,4-D on willows (locally termed sand bar willows) in test plots on seven Bureau of Reclamation projects located in Montana, Wyoming and South Dakota. The spraying was done on a total area of about 11 acres from June to September. The following observations were made:

1. The reaction was not complete by the following spring, but seemed to carry over into the summer. Patches showing as high as 30% survival in the spring later showed only about 5%.
2. There was a wide range in rates of application from 3 (or perhaps lower) to 6 pounds per acre.
3. An application of enough liquid to wet the foliage without waste at 1,000 PPM gave equally good results as higher rates of concentration.
4. There have been no material differences noted with applications made at different stages of growth.
5. No material differences have been observed with different types of 2,4-D, i.e., sodium salts versus esters.
6. There is some indication that diesel fuel added to the mixture increases the effectiveness of 2,4-D.

Work done in the 1947 season may narrow down some of the vague points, but early reports tend to verify observations of 1946. (Contribution of Bureau of Reclamation, Region 6, Billings, Montana.)

Effect of 2,4-D on willows and cottonwood in northwestern Minnesota. Spring, E.W.1/ We have been using the following 2,4-D:

Weedone	American Chemical Paint Co.	9.6% Ethyl ester
Weed-no-more	Sherwin-Williams	40.0 Butyl ester
Esteron 44	Dow	44.0 Isopropyl ester

Using the Dow preparation with 2600 parts of active ingredient to a million parts of diesel fuel we (apparently) had a 100% kill on small willows up to 6' in one week with one application. We had 772 cottonwood trees up to 15" in diameter which were either pulled with a tractor, dynamited, or close cut. The new growth up to 7 and 8' is what we sprayed with the 2,4-D. One application checked the new growth on most of the 4 miles we worked on. A second application killed much of it and we are now waiting for the results on the third application. We found that painting the cambium was not too effective. (1/ The Spring Gravel Company, Crookston, Minnesota.)

Killing alder brush with herbicides. Stoeckeler, J. H. and N. T. Samson. At the Northern Wisconsin Forest Research Center, we found spraying with Weedone, Esteron and Ammate caused a heavy foliage loss in alder, but the stems (at the end of the season in which spraying was done) still appear green and we fear they will leaf out with good vigor again in the spring of 1948. Hence our results are totally inconclusive until we make a fall 1948 count. From present indications, a good treatment is to cut all alder in May and then spray the leaves of the resulting sprouts in late July or August of the same year, or when they are several feet high, using strong concentrations of Ammate or Esteron at a strength of 3/4 of 1 percent. Such a treatment, however, will be rather expensive, probably about $21 to $30 per acre, which includes the cost of cutting, spraying and chemicals. Esteron will be somewhat cheaper than Ammate, based on our present experience. (Contribution of Lake States Forest Experiment Station, University Farm, St. Paul, Minnesota.)

Miscellaneous Reports and memoranda concerning control of willows. Thompson, Jesse R., T. L. Sundquist, H. W. Emery, Elmer Sabin, W. H. Hirst, et al. Willows have been effectively controlled on Reclamation projects in the intermountain area by spraying them with various formulations of 2,4-D by mixing one part of 2,4-D acid equivalent to 1,000 parts of water. Increasing the dosage to one part per 500 did not show appreciable gains in effectiveness, while mixing one part of sodium salts of the acid to 1,500 parts of water proved to be comparatively ineffective. It was observed that complete coverage of the willow was necessary and that any method of application which failed to give complete coverage, such as spraying by airplane, gave poor results. It was also noted that the amount of regrowth in the form of new shoots will vary considerably, depending upon factors which have not been determined. (Contribution of Reclamation, Region 4, Salt Lake City, Utah.)

Effect of isopropyl ester of 2,4-D on Prunus Americana seedlings. Viehmeyer, Glenn, Horticulturist. On July 14, 1947, an exploratory experiment to determine the effect of 2,4-D on woody plants was started. Two-year-old seedlings of wild plum, 3/8 to 1-1/2 inches caliper and growing in the nursery, were used as test plants. These trees were sawed off 1-2 inches above ground and a 40% commercial formulation of the ester was diluted to a 20% solution with gasoline and applied to the freshly-cut stumps with a brush. About 1 oz. of the solution was required to treat 100 plants. On October 1, 1947, counts were made; 8.5% of treated plants showed some regrowth. Shoots from these plants ranged from 1/2 to 8 inches long and showed typical 2,4-D distortion in both stem and leaf. Untreated checks had shoots 18 to 30 inches long; 91.5% of treated plants showed no regrowth; and 2,4-D effects ranged from complete prevention of shoot production to complete death of the entire root system. Results of the test indicate that the ester of 2,4-D applied to freshly-cut stumps may give a high degree of control of wild plum but that various degrees of tolerance to the chemi-

cal exist in the species. The degree of control secured may be affected by the degree of tolerance of the particular race of wild plum treated. (Contribution of the University of Nebraska Substation, North Platte, Nebraska.)

Herbicidal effect of ammonium sulfamate on Berberis canadensis Mill. Watson, W. M. and L. W. Melander. Preliminary field tests conducted in West Virginia during 1942 and 1944, followed by more extensive tests in 1946, show that ammonium sulfamate is highly toxic to B. canadensis. Treatments of 2, 3, 4, 5, and 6 pounds of amate per square rod, applied as foliage sprays in the early summer and midsummer, killed all of the growing canes. With the fall applications, dosages of 4, 5, and 6 pounds of amate were found necessary to obtain the same results. Considering the sprouts that appeared on the plots during the current year and in 1947, the early summer applications were the most effective, with midsummer next, and fall treatments the least effective. Dosages of 2 and 3 pounds of amate per square rod applied in midsummer, and 4, 5, and 6 pounds in the early fall appear to be even more toxic to the canes of B. canadensis than comparable dosages of sodium chlorate, which was used as a check in all cases against the amate treatments. More plots were treated with amate in 1947, but the results will not be available until next year. (Contribution of Div. of Plt. Dis. Cont., Bur. of Ent. & Plt. Quar., USDA.)

Effect of 2,4-D on elderberry. Willard, C. J. A clump of elderberry bushes 5 to 7 feet tall was thoroughly sprayed June 26, 1945, with the sodium salt of 2,4-D at 1500 ppm and at least 6 gallons per square rod or at least 8 pounds per acre. The top growth was all killed but there were some resprouts from the base that fall; likewise, the next spring. The clump was resprayed on June 8, 1946, at the same concentration but, of course, much less spray used. Resprouting followed in 1947. The clump was sprayed again on May 24th but it is not yet killed. Obviously, it can be if the treatments are repeated sufficiently. Experiences with elderberries in fence lines elsewhere are similar. (Contribution of Ohio Agricultural Experiment Station in cooperation with the Dow Chemical Company.)

Effect of 2,4-D on poison ivy. Willard, C. J. Between 100 and 200 plots of poison ivy have been experimentally sprayed or dusted with 2,4-D preparations at Columbus and vicinity in the course of these investigations. The ester formulations are much more active and effective than the salt formulations although 100 percent kills have been obtained with the latter under favorable conditions. Under the most favorable conditions, a concentration of 2 pounds per acre of the acid in ester form has given essentially 100 percent kills. There is bound to be some regrowth in any extensive weed-killing operation. Complete kills have been obtained at any time from when the leaves were about 1/4 expanded until late fall when autumn coloration was beginning. Fall treatments appeared to be particularly effective; likewise, summer treatments in orchards. On the other hand, there have been a considerable number of failures to kill poison ivy under a wide variety of conditions, so that we are never quite sure of the result when we apply 2,4-D to a poison ivy patch. Nevertheless, we would recommend 2,4-D esters as the most convenient and economical method of eradicating poison ivy. Ammonium sulfamate, 1 pound to the gallon of water, applied at 1 to 3 gallons per square rod, has been the surest "one-shot" treatment for poison ivy, but it is so expensive that it will not compete strongly with the ester formulations of 2,4-D. (Contribution of Ohio Agricultural Experiment Station in cooperation with the Dow Chemical Company and the Sherwin-Williams Company.)

Killing elm trees with 2,4-D. Witman, E. D. No effect was noted on 30-foot elm trees from 10 ml. of 40% butyl ester formulation of 2,4-D introduced to the cambium by means of a 3/8" pipe nipple pounded into the cambium layer. This may be accounted for by the fact that the herbicide level did not change in the pipe over a period of three weeks. The bark in the pipe apparently functioned as an efficient cork.) The test was run in August. (Contribution of the Sherwin-Williams Company, Cleveland, Ohio.)

Killing poison ivy (Rhus toxicodendron) with 2,4-D. Wood, H. E. During 1945-46, 29 plots of dense poison ivy on porous shale mostly exposed to the sun were treated in July and early August with various formulations of 2,4-D at .1 to .2 concentrations. Kills as checked to August, 1947, while ranging from nil to practically 100%, were in the main satisfactory, the esters and amine salts proving considerably better than the ammonium or sodium salts. June 12th, 1947, 3 plots on clay soil, in shade, sprayed with 1 pound acid per acre respectively, Esteron 44, Weed-No-More 40, and Hormono Ivy Kill, July 21st appeared 95% killed, but by September 9th showed 100% recovery. (Contribution of the Weeds Commission, Manitoba Department of Agriculture, Winnipeg, Canada.)

Killing snowberry (Symphorecarpus racemosus) with 2,4-D. Wood, H. E. On July 11, 1947, two one-acre plots in a pasture field sparsely infested with snowberry 16 inches in height, still succulent but past flowering was sprayed by machine with an isopropyl ester at 1 and 2 pounds acid per acre. Except for traces of browning of leaves, treatments had no effect upon the plants. Where the occasional plant had been knapsack sprayed with a 1-to 2-pound acid concentration of ester or amine salt, in early spring when growth was tender, snowberry appeared susceptible. (Contribution of the Weeds Commission, Manitoba Department of Agriculture, Winnipeg, Canada.)

Killing white poplar (Populus tremuloides), with 2,4-D. Wood, H. E. and G. R. Fraser. On May 30th, 1947, 6 plots of regrowth poplar about 8 feet in height were sprayed at 2 pounds acid per acre, sodium salt, amine salt, and ester, and 3 plots with another ester at concentrations of 1, 2 and 4 pounds. While growth was retarded -- estimated from 50% to 77%, the sodium salt the lowest, the 4-pound concentration ester the highest -- the poplars were not dead above ground when a ditching machine moved over the plots in late September. (Contribution of the Weeds Commission, Manitoba Department of Agriculture, Winnipeg, Canada.)

Killing willow (chiefly Salix amygdaloides) with 2,4-D. Wood, H. E. Although no plot work was conducted, the Manitoba Drainage Maintenance Board by use of a Buffalo Turbine, sprayed during 1947, approximately 100 miles, comprising 642½ acres, of drainage and road ditches, with willows from three to twenty feet in height, the major problem. Both an ester and amine salt were used at approximately 1½ pounds acid in 5 imperial gallons water per acre. Apart from misses in coverage an excellent kill was obtained with little indication of any considerable regrowth. Several municipalities, using boom equipment, treated limited trial areas of road ditches with similar results. (Contribution of the Weeds Commission, Manitoba Department of Agriculture, Winnipeg, Canada.)

The effect of 2,4-D and other chemicals and different methods of treatment on tree sprouts. Zahnley, J. W. Tree sprouts mainly elm ranging from one-half to two inches in diameter were treated with sodium salt of 2,4-D, butyl

ester of 2,4-D, ammate, and sodium chlorate (1) by hacking the stems and applying the undiluted chemical to the wound, (2) cutting the plants and spraying the stumps with a high concentration (8%) of 2,4-D butyl ester and (3) cutting the plants and spraying the regrowth. All treatments except on the regrowth were made July 9, 1947. On October 20, plants hacked through the bark on 3 or 4 sides of the trunk and treated with the ester of 2,4-D were all dead. Seventy-five percent of the tops of plants treated similarly with sodium salt were killed but all had green leaves below the tops. Plants treated with ammate by this method were not severely injured. Sixty-five percent of the tops were dead on those treated with sodium chlorate but sprouts were starting from the base. Ninety percent of the stumps that were sprayed immediately after cutting failed to produce regrowth and seem to be killed. Plants cut and treated after regrowth and well started appear to be killed. Treatment of sprouts of Osage hedge and mulberry failed to kill. (Contribution of the Department of Agronomy, Kansas Agricultural Experiment Station, Manhattan, Kansas.)

The effectiveness of different types of 2,4-D in the eradication of buckbrush and sumac. Zahnley, J. W. Duplicate treatments on buckbrush (Symphoricarpus orbiculatus) and on sumac (Rhus glabra) were made June 6, 1946, comparing five different esters, ethyl, butyl, isopropyl, amyl, and loro, and sodium salt, ammonium salt, triethanolamine, and methoxone at the rate of 2.4 pounds per acre. Final observations for the season were made November 6, 1946. Results with the different esters were similar. All were decidedly more effective on buckbrush than the other formulations. 25 to 40% of the stems were dead to the ground or within 2 inches. Some regrowth appeared from the base of the plants only. Plants treated with sodium and ammonium salts had lost most of their leaves earlier but 75% of the stems were still green almost to the top; about 15% had made some regrowth but no basal shoots. 5% were dead to near the ground. Only 5% of the plants treated with methoxone and triethanolamine salt were making regrowth; otherwise, results were similar to sodium and ammonium salts. All plots were retreated June 9, 1947, using only isopropyl and butyl esters. On October 23, 1947, variations of results from the previous year's treatments had disappeared and 95% of the plants on all plots were dead and most of the crowns were decaying. A few very weak shoots were starting from the live plants that remained. The treatments in 1946 were more effective on sumac than on buckbrush and there was no significant difference in the effect of the different formulations. Sumac seemed to be more readily killed by 2,4-D. (Contribution of the Department of Agronomy, Kansas Agricultural Experiment Station, Manhattan, Kansas.)

REACTION OF WOODY PLANTS TO 2,4-D FORMULATIONS
Composite Summary of all Data Submitted
to the Subcommittee on Woody Plants
R-Resistant I-Intermediate S-Susceptible

Woody Plants		State or Prov.	Authority	Reaction to 2,4-D Form.: Fol. Sprays	Cut Surf.	Exposed Cambium	Remarks
Common Name	Scientific Name						
Alder	Alnus incana	Mich.	MWD	S		S	
		Minn.	Sch. Hans.	S			Esters & amines
Ash	Fraxinus sp.	Mich.	Grig.	R			Salts, esters acidi.
Ash, prickly	Xanthoxylum americanum	Pa.	Berg.	R	S		Esters & amines
Ash, red	Fraxinus pennsylvanica	Minn.	Kruse	R	S	S	Esters
		Ohio	CJW	R			
Aspen	P. tremuloides (See poplar)						
Azalea	Rhododendron sp.	Del.	DuPont	R			1% amm. salt
Barberry, E. native	Berberis canadensis	W.Va.	Mel.	R			Salts, esters, amines
Barberry, W. native	Berberis fendleri	Colo.	Mel	S			Salts, amines, esters
Beech	Fagus sp.	Del.	DuPont	R			.2% amm. salt
Birch, paper	Betula papyrifera	Mich.	MWD	S			
Bittersweet	Celastrus scandens	Iowa	B & S	R			Ester
		Wis.	Briggs			R	Esters & amines
Blackberry	Rubus nigrobaccus	Minn.	Sch. Hans.	R			Esters & amines
Blackberry briars	Rubus sp.	Pa.	Berg.	R			Esters & amines
		Miss.	L&A	R			Esters or salts
		Ohio	CJW	R			
		Del.	DuPont	R			.2% amm. salt
Bois d'arc (See osage orange)							
Box elder	Acer negundo	Man.	Wood	S			Esters & amines
		Minn.	Kruse	S	S	S	All form.
		Nebr.	Hans.	I			Esters & amines
		Iowa	B & S	S	S	S	Esters
		Mich.	Grig.	S			
		Wis.	Briggs	S-I			Esters & amines
Buckbrush	Symphoricarpus sp.	Iowa	B & S	R			Esters-slowly killed
Buckbrush	Symphoricarpus occidentalis	Neb.	Vie.	I			Salts
Buckbrush (Coral berry)	Symphoricarpus orbiculatus	Neb.	Hans.	R			Esters & amines

Woody Plants		State or Prov.	Authority	Reaction to 2,4-D Form.: Fol. Sprays	Cut Surf.	Exposed Cambium	Remarks
Common Name	Scientific Name						
Buffalo berry, silver	Sherpedia argentia	Sask.	Fries.	S			Butyl ester
Cat briar	Smilax sp.	Del.	DuPont	R			.1% amm. salt
Cedar	Juniperus virginiana	Del.	DuPont	R			.1% amm. salt
		Okla.	HME	R	R		Esters--2000 ppm
Cedar, salt	Tamarix gallica	Tex.	WHM	S			When young
Cherry, choke	Prunus virginiana	Mich.	MWD	S			
		Neb.	Hans.	R			Ester, butyl
Cherry, pin	Prunus pennsylvanica	Mich.	MWD	S	S		
		Minn.	Sch. Hans	S			Esters & amines
Cherry, sand	Prunus bessyii	Neb.	Vie.	S			Salts
Cherry, wild	Prunus sp.	Pa.	Berg.	S			Esters
		Mich.	Grig.	S			Any form.
		Wis.	Briggs		I		Esters & Amines
		Del.	DuPont	S			.2% amm. salt
Cherry, wild	Prunus serotina	Ohio	CJW	I			
		Minn.	Sch. Hans.	S			Esters & amines
Cherry, wild	Prunus virginiana	Minn.	Kruse.	I	S	S	Esters
Chestnut	Castanea sp.	Del.	DuPont	R			.2% amm. salt
Cottonwood	Populus deltoides	Ohio	CJW	R			
Cottonwood	Populus sargentii	Neb.	Vie.	S			Sodium salt
Currant, Alpine	Ribes montigenum	Calif.	Off.	R			Salts, esters, amines
Currant, Amer. black.--	Ribes americanum	Calif.	Off.	S			Salts, esters, amines
Currant, Amer. red	Ribes triste	Calif.	Off.	R			Salts, esters, amines
Currant, golden	Ribes aureum	Neb.	Vie.	S			Sod. salt
Currant, prickly	Ribes lacustre	Calif.	Off	R	S		Salts, esters, amines
Currant, red-flowering	Ribes sanguineum	Calif.	Off.	I	S		Salts, esters, amines
Currant, Sierra Nev.	Ribes nevadense	Calif.	Off.	S	S	S	Salts, esters, amines
Currant, squaw	Ribes cereum	Calif.	Off.	S	S	S	Salts, esters, amines
Currant, sticky	Ribes viscosissimum	Calif.	Off.	I	S		Salts, esters, amines
Currant, stink	Ribes bracteosum	Calif.	Off.	S	S		Salts, esters, amines
Currant, Western black	Ribes petiolare	Calif.	Off.	S	S	S	Salts, esters, amines

Woody Plants		State or Prov.	Author-ity	Reaction to 2,4-D Form.			Remarks
Common Name	Scientific Name			Fol. Sprays	Cut Surf.	Exposed Cambium	
Currant, wild	Ribes floridum	Mich.	Grig.	R			
Dogbane	Apocynum canabum	Iowa	B & S	R			Esters
Dogwood	Cornus sp.	Minn.	Kruse.	S	S	S	All form.
		Mich.	Grig.	R			Salts
		Del.	DuPont	I			.4% amm. salt
Dogwood	Cornus alternifolia	Mich.	MWD	R			
Dogwood	Cornus stolonifera	Sask.	Pavl.	S			All form.
Dogwood, red osier	Cornus stolonifera	Mich.	MWD	R			
Elderberry	Sambucus canadensis	Neb.	Vie.	I			Salts
		Ohio	CJW	I			
		Mich.	Grig.	S			Esters
Elderberry	Sambucus sp.	Pa.	Berg.	S			Esters
		Wis.	Briggs	S			Esters & amines
Elm	Ulmus sp.	Iowa	B & S	R			Esters
		Ohio	WJG	S			Esters
Elm, American	Ulmus americana	Neb.	Vie.	R			Sod. salt
		Minn.	Kruse.	S	S	S	Esters
		Neb.	Hans.	I			Ester, butyl
		Ohio	CJW	I-S			
		Mich.	Grig.	I			
		Wis.	Briggs	I-S			Esters & amines
		Okla.	HME	R	R		Esters, 2000 ppm
Elm, Chinese	Ulmus pumila	Neb.	Vie.	I			Sod. salt
		Neb.	Hans.	I			Ester, butyl
Elm, winged	Ulmus alata	Okla.	HME	R	R		Esters, 2000 ppm
Gooseberry, gummy	Ribes lobbii	Calif.	Off.	I	S		Salts, esters, amines
Gooseberry, Sierra Nev.	Ribes roezli	Calif.	Off.	S	S	S	Salts, esters, amines
Gooseberry, Siskiyou	Ribes binominatum	Calif.	Off.	R			Salts, esters, amines

Woody Plants		State or Prov.	Authority	Reaction to 2,4-D Form.: Fol. Sprays	Cut Surf.	Exposed Cambium	Remarks
Common Name	Scientific Name						
Gooseberry, whitestem--	Ribes inerme	Calif.	Off.	R	S		Salts, esters, amines
Grape	Vitus sp.	Del.	DuPont	S			.2% amm. salt
Grape, dwarf Oregon	Mahonia repens	Colo.	Mel.	R			Salts, amines, esters
Grape, wild	Vitus vulpina	Minn.	Kruse.	S	S	S	All form.
		Mich.	Grig.	S			All form.
		Wis.	Briggs	S			Sodium salt
Gum, cork	Liquidambar sp.	Del.	DuPont	I			.4% amm. salt
Gum, sweet	Liquidambar styraciflua	Miss.	L & A		I		Sodium salt
Hackberry	Celtis occidentalis	Neb.	Vie.	R			
		Okla.	HME	R			
		Ohio	WJG	S			Esters
		Okla	HME	R	R		Esters, 2000 ppm
Hawthorn (thornapple)	Crataegus sp.	Mich.	MWD	S	S		
		Mich.	Grig.	R			Esters and salts
		Wis.	Briggs			R	Esters & amines
		Del.	DuPont	R			.1% amm. salt
Hazel brush	Corylus americana	Pa.	Berg.	S			Esters & amines
		?	?	S			Sodium salt
		Iowa	B & S	R			Esters
		Wis.	Briggs	I			Esters & amines
		Minn.	Sch.Hans.	S			Esters & amines
Hazel brush	Corylus rostrata	Minn.	Sch.Hans.	S			Esters & amines
Hazel nut	Corylus cornuta	Mich.	MWD	S	S		
Hercules Club	Aralia spinosa	Del.	DuPont	S			.1% amm. salt
Hickory	Hicoria buckleyi	Okla.	HME	R	R		Esters, 2000 ppm
Holly	Ilex sp.	Del.	DuPont	R			.1% amm. salt
Honeysuckle Jap	Lonicera japonica	Miss.	L & A	S			Ester
Ironwood	Carpinus sp.	Del.	DuPont	S			.1% amm. salt

Woody Plants		State or Prov.	Authority	Reaction to 2,4-D Form.			Remarks
Common Name	Scientific Name			Fol. Sprays	Cut Surf.	Exposed Cambium	
Ivy, poison	Rhus toxicodendron	Man.	Wood	S			Esters and amines
		Miss.	L & A	S			Esters
		Neb.	Hans.	I			Esters, butyl & ethyl
		Idaho	Erick.	I-S			Amine - July
		Ohio	CJW	I-S			Esters more eff.
		Iowa	B & S	S			Esters
		Mich.	Grig.	S			Esters & acid salts
		Wis.	Briggs	S-I			Esters & amines
		Del.	DuPont	I			.4% amm. salt
Ivy, poison woody	Rhus quercifolia	Pa.	Berg.	S-R			Esters
Ivy, wild	Ampelopsis cordata	Miss.	L & A	S			Ester
June berry	Amelanchier sp.	Mich.	MWD	S			
Laurel	Kalmia sp.	Del.	DuPont	R			.2% amm. salts
Licorice, wild	Glyceriza lepidota	Iowa	B & S	S			Esters
Lilac	Syringia persica	Neb.	Hans.	I			Esters & amines
Lilac (common)	Syringia vulgaris	Man.	Wood	S			Ester
Locust, black	Robinia pseudoacacia	Neb.	Hans	R			Ester, butyl
		Idaho	Erick.	R			Acid, carbo.
		Del.	DuPont	S			.2% amm. salt
		Okla.	HME	I	I		Esters, 2000 ppm
Locust, honey	Gleditsia triacanthos	Neb.	Hans.	R			Ester, butyl
		Ohio	WJG	R			Esters
		Okla.	HMR	I	I		Esters, 2000 ppm
Maple	Acer sp.	Del.	DuPont	R			.4% amm. salt
		Ohio	WJG	S			Esters
Maple, dwarf	Acer glabrum	Neb.	Vie.	I			Sod. salt
Maple, hard	Acer saccharum	Minn.	Kruse.	R			All form.
Maple, mountain	Acer spicatum	Mich.	MWD	R			
Maple, red	Acer rubrum	Mich.	MWD	R	I	R	
Maple, soft	Acer saccharinum	Minn.	Kruse.	R			All form.
		Ohio	CJW	I			

Woody Plants		State or Prov.	Author-ity	Reaction to 2,4-D Form.: Fol. Sprays	Cut Surf.	Exposed Cambium	Remarks
Common Name	Scientific Name						
Matrimony vine	Lycium halimifolium	Neb.	Vie.	S			Esters or salts
		Neb.	Hans.	R			Ester, butyl
Meadow sweet	Spirea salicifolia	Mich.	Grig.	S			Any form.
Mesquite	Prosopis juliflora glandulosa	Okla.	HME	R	R		Esters, 2000 ppm
Moonseed vine	Menispermum canadense	Iowa	B & S	S			Esters
Mulberry	Morus alba	Neb.	Hans.	I			Esters & amines
		Mich.	Grig.	R			
Oak	Quercus sp.	Pa.	Berg.	R			Esters
		Wis.	Briggs		I		Esters & amines
		Del.	DuPont	R			.2% amm. salt
Oak, black	Quercus ellipsoidalis	Minn.	Kruse.	R	S	S	All form.
Oak, blackjack	Quercus marilandica	Okla.	HME	I	R		Esters, 2000 ppm
Oak, chestnut	Quercus prinus	Del.	DuPont	R			.4% amm. salt
Oak, dwarf chinquapin	Quercus muhlenbergii	Okla.	HME	I	R		Esters, 2000 ppm
Oak, post	Quercus stellata	Okla.	HME	I	R		Esters, 2000 ppm
Oak, scrub or bur	Quercus macrocarpa	Man.	Wood	R			Apparently all form.
Oak, white	Quercus alba	Minn.	Kruse.	R	S	S	All form.
Olive, Russian	Eleagnus angustifolia	Idaho	Erick.			S	Sod. salt & amine
Osage orange	Maclura pomifera	Neb.	Hans.	R			Ester, butyl
		Iowa	B & S	R			Esters
		Okla.	HME	R	R		Esters, 2000 ppm
Papaw	Asimina sp.	Del.	DuPont	R			.4% amm. salt
Pea, Siberian	Caragana arborescens	Man.	Wood	S			Prob. all formulations
Pepper vine	Ampelopsis arborea	Miss.	L & A	S			Ester
Persimmon	Diospyrus virginiana	Del.	DuPont	S			.4% amm. salt
		Okla.	HME	I	I		Esters, 2000 ppm
Pine, loblolly	Pinus taeda	Del.	DuPont	R			.1% amm. salt
Pine, Virginia	Pinus virginiana	Del.	DuPont	R			.4% amm. salt
Pine, white	Pinus strobus	Mich.	Grig.	R			Young seed. sus.

Woody Plants		State or Prov.	Authority	Reaction to 2,4-D Form.			Remarks
Common Name	Scientific Name			Fol. Sprays	Cut Surf.	Exposed Cambium	
Plum, sand	Prunus angustifolia	Okla.	HME	I	I		Esters, 2000 ppm
Plum, wild	Prunus americana	Neb.	Vie.	I	S		Esters & salts
		Neb.	Hans.	I			Esters, butyl & ethyl
Poplar	Populus sp.	Iowa	B & S	S			Esters
		Ohio	WJG	S			Esters
Poplar, Carolina	Populus sp.	Idaho	Erick.			S	Amine salts
Poplar, tulip	Liriodendron sp.	Del.	DuPont	I-S			.4% amm. salt
Poplar, white	Populus alba	Neb.	Hans.	S			Esters & amines
Poplar, white (aspen)	Populus tremuloides	Man.	Wood	I			Sod. & amine salts & esters
		Minn.	Kruse.	S	S	S	Esters
		Mich.	MWD	I		S	
		Wis.	Briggs	S-I			Esters & amines
Privet hedge	Ligustrum vulgare	Miss	L & A	R			Esters
Rabbit bush	Crysothamus sp.	Neb.	Vie.	S			Sod. salt
Rabbit bush	Crysothamnus nauseosus	Utah	GS	S			Tentative
Raspberry	Rubus sp.	Mich.	Grig.	R			Salts
Raspberry	Rubus strigosis	Minn.	Sch.Hans.	R			Esters & amines
Rose, wild	Rosa sp.	Colo.	Mel.	R			Salts, amines, esters
		Idaho	Erick.	R			Esters & salts
		Utah	GS	I			Tentative
Rose, wild	Rosa blanda	Neb.	Hans.	R			Esters & amines
Sagebrush	Artemisia sp.	Neb.	Vie.	S			Ester
Sagebrush	Artemisia tridentata	Utah	GS	S			Tentative
Sassafras	Sassafras variifolium	Del.	DuPont	S			.2% amm. salt
		Okla.	HME	I	I		Esters, 2000 ppm
Snowberry	Symphoricarpus occidentalis	Sask.	Fries.	R			Butyl ester
Snowberry (see buckbrush)	Symphoricarpus racemosus	Man.	Wood	R (Except when tender)			Esters
Spice brush	Benzoin sp.	Del.	DuPont	R			.2% amm. salt
Spruce, blue	Picea sp.	Ohio	CJW	R-I			
Spruce, green	Tsuga canadensis	Neb.	Hans.	R			Esters & amines

Woody Plants		State or Prov.	Authority	Reaction to 2,4-D Form.			Remarks
Common Name	Scientific Name			Fol. Sprays	Cut Surf.	Exposed Cambium	
Sumac	Rhus sp.	Iowa	B & S	S			Esters
		Wis.	Briggs	S-I			Esters & amines
Sumac	Rhus glabra	Neb.	Vie.	R-Summer			Sod. salt
		Pa.	Berg.	S			Esters
		Minn.	Kruse.	S	S	S	All form.
		?	?	S			Sod. salt
		Neb.	Hans.	S			Ester, butyl
		Idaho	Erick.	I-S			Amine - July
		Okla.	HME	I	I		Esters, 2000 ppm
Sumac, dwarf	Rhus capallina	Del.	DuPont	S			.2% amm. salt
Sumac, poison	Rhus vernix	Mich.	Grig.	S			Esters preferred
Sycamore	Platanus sp.	Del.	DuPont	R			.1% amm. salt
		Ohio	WJG	S			Esters
Trumpet vine	Tecoma sp.	Del.	DuPont	I-S			.4% amm. salt
Virginia creeper	Ampelopsis quinquifolia	Mich.	Grig.	S			Any form.
		Neb.	Vie.	S			Salts
		Ohio	CJW	S			
		Iowa	B & S	S			Ester
Virginia creeper	Psedera sp.	Del.	DuPont	S			.2% amm. salt
Virgin's Bower	Clematis lingustifolia	Neb.	Vie.	S-early R-summer			Sod. salt
Waahoo	Euonymus atropurpureus	Neb.	Vie.	I			Sod. salt
Walnut, black	Juglans nigra	Neb.	Hans.	S			Ester, butyl
Willow	Salix sp.	Mich.	MWD	S			
		Iowa	B & S	S			Esters
		Minn.	Sch.Hans.	S			Esters, amines
		Okla.	HME	I			
		Tex.	WHM	S			
		Ohio	WJG	S			Esters
Willows, in general	Salix sp.	Idaho	Erick.	I			R in early spring

Woody Plants		State or Prov.	Authority	Reaction to 2,4-D Form.			Remarks
Common Name	Scientific Name			Fol. Sprays	Cut Surf.	Exposed Cambium	
Willow	Mostly Salix amygdaloides	Man.	Wood	S			Esters, amines
Willow	Salix nigra	Okla.	HME	I	R		Esters, 2000 ppm
Willow, arroyo	Salix lasiolepas	Wash.	VFB	I-S			Tentative
Willow, brittle	Salix fragilis	Idaho	Erick.			S	Acid & amines
Willow, glossy	Salix lucida	Idaho	Erick.	I			But. ester & amines
Willow, heart-leaved	Salix cordata	Idaho	Erick.	I			Acid or amines
Willow, peach-leafed	Salix amygdaloides	Neb.	Hans.	S			Esters, but. & iso.
		Ohio	CJW	I			
Willow, silver	Salix discolor	Idaho	Erick.	I			Acid or amine
Willow, white	Salix alba	Wis.	Briggs	S			Esters & amines
Winter berry	Ilex verticillata	Mich.	Grig.	S			Salts

RESULTS OF NON-UNIFORM AND MISCELLANEOUS EXPERIMENTS

Compiled by W. C. Dutton

ABSTRACTS

2,4-D in conjunction with competitive crops. Carder, A. C. This investigation was undertaken on hoary cress (Lepidium draba). Commenced in 1946, it included the seeding of turf-forming grasses such as creeping red fescue, Kentucky blue, timothy, and crested wheatgrass in conjunction with two treatments per season of a 2,4-D ester at .2 percent solution. The immediate effect of the early-season chemical was a fascilated condition of the hoary cress. No root injury was noticed, however, and resprouts were evident by late summer. Autumn retreatments were given. The infestations in 1947 showed sign of severe weakening while the various grasses closed in and firmly established themselves. There was no evidence of cress in the late autumn of the second season but reoccurrence of growth is to be watched for in 1948. Type of grass employed is not important providing it is adaptable to the soil conditions wherein the weed infestation exists. (Contributed by The Canada Department of Agriculture, Beaverlodge, Alberta.)

2,4-D on seedling weeds in growing grains. Carder, A. C. Several trials, including plot treatment and field application by powered units, comprised this investigation. A number of weed species were studied: stinkweed (Thlaspi arvense), wild mustard (Brassica arvensis), ball mustard, shepherd's purse, peppergrass (Lepidium apetalum), lamb's quarters, wild buckwheat (Polygonum convolvulus), and blue bur (Lappula echinata). When applications were conducted at the most susceptible stage of weed growth (several true leaves to first sign of budding) and under favorable weather conditions kills of stinkweed and the mustards with an .05 percent ester or a .10 percent sodium or amine salt ran from 85 to 90 percent and occasionally higher. Shepherd's purse proved more resistant and required a .10 percent ester or a .15 percent salt to be effectively controlled. Observations indicate lamb's quarters, blue bur, and wild buckwheat to be even more tolerant, in the order named. The ester formulations produced a more rapid and pronounced effect than the salts when used at the same concentrations. In one instance malformation of wheat heads was noted, induced by as low as an .05 percent ester when applied on a 6-inch stand of grain. It was not determined if the yield was affected. This condition was found to be extremely rare with 2,4-D salts at .10 percent concentration. (Contributed by The Canada Department of Agriculture, Beaverlodge, Alberta.)

2,4-D on annual and winter annual weeds in young grass stands. Carder, A. C. It is frequently a problem to combat annual and winter annual weeds in newly-established meadow stands. Several trials were made on fields of creeping red fescue badly infested with stinkweed (Thlaspi arvense), pepper grass (Lepidium apetalum), both as annuals and winter annuals and with the wild and ball mustards. The use of an ester at .15 percent concentration gave very effective control with no apparent repressive effects on the grass. Early treatment to catch the winter annuals in the rosette or early bud stage is essential. (Contributed by The Canada Department of Agriculture, Beaverlodge, Alberta.)

2,4-D on broad-leaved lawn weeds. Carder, A. C. Dandelion is the chief offender in this case. Very disappointing results were had with this

weed. It would seem that once a dandelion plant has put in a winter and has become well established it has considerable tolerance towards 2,4-D. Only with concentrations of from .15 to .20 percent and use of an ester did the older plants die out and then not in any case more than 30 percent. In 1947 an autumn retreatment was applied in addition to the spring application. To date, this dual treatment offers hope of the eradication of this pest. Killing varied from 60 to 70 percent and the surviving plants were in a very weakened condition and may well succumb to the winter. (Contributed by The Canada Department of Agriculture, Beaverlodge, Alberta.)

2,4-D application to persistent perennial weeds. Carder, A. C. In 1947 a number of trials were laid down to investigate the effectiveness of 2,4-D in eradicating several of the more noxious weeds of this region. The ester formulation at .2 percent concentration was emphasized though other types and concentrations were studied. The experiments were conducted on hoary cress (Lepidium draba), Canada thistle, and toadflax. Treatment consisted of spring and autumn applications. There is every indication that the complete eradication of these weeds is more than a one-season undertaking and little can be reported at this stage. A competitive crop may be a necessary adjunct. Following two treatments of a .2 percent ester a well established infestation of Canada thistle still developed occasional resprouts. To date, Canada thistle would appear to have under 2,4-D treatment about the same degree of persistency as hoary cress. Toadflax indicates considerable tolerance to 2,4-D and it is doubtful if it can be eradicated by this chemical. (Contributed by The Canada Department of Agriculture, Beaverlodge, Alberta.)

The effect of dosage and stage of growth in the control of annual and winter annual weeds. Freisen, H. A.* Three dosages, viz.; 4, 8 and 16 ounces per acre were applied at four stages of growth of spring wheat. Three formulations of 2,4-D were used. Treatments made two days previous to emergence of the grain were effective in destroying the few seedlings of Stinkweed and Russian thistle already emerged but had no effect on the ungerminated weed seeds in the soil. Consequently, weed growth was equally dense on treated and untreated plots. Treatments at the three leaf, the shot blade and flowering stages of the crop were quite effective against Stinkweed and lambs' quarters. The most effective control of Russian thistle resulted from the use of the butyl ester at the early shot blade stage of the crop before the thistle had branched extensively. The butyl ester tended to be twice as effective in the control of Russian thistle, at all stages of growth, as was the amine or sodium salt type. Wild buckwheat was stunted but not killed by any of the formulations or dosages at any stage of growth. (Assistant in Field Husbandry, Dominion Experimental Station, Scott, Sask.)

Pre-emergence control of weeds in corn with 2,4-D. Olson, P. J. and Zalik, Saul. A mixture of weed seeds consisting of lambs' quarters, wild mustard, stinkweed, wild buckwheat, hare's ear mustard, green foxtail, pigweed, Russian pigweed, ball mustard, Russian thistle and stickweed was broadcast on each of the plots including the checks on May 22nd. Corn was planted on each of these plots on May 23rd. The ester (butyl) form of 2,4-D was applied June 2nd at 2 rates; 2 lbs. and 4 lbs. per acre (pure acid equivalent). There was practically complete control of all weeds except Russian thistle (which grew normally) on the treated plots. There was vigorous growth of all the weeds on the check plots. Neither of the rates caused any visible damage to the corn. Since the weed growth on the untreated plots was so profuse as to almost completely

overgrow the corn, very low yields of dry matter were produced there, (practically no ears were produced). The treated plots yielded approximately three times as much total dry matter as the check plots. A cooperator applied pre-emergence sprays to heavily weed infested land, planted two days previously to field corn. As ester (butyl) was applied at two rates, namely, 1¼ and 2½ pounds acid per acre. Excellent control was achieved of all susceptible annual weeds; field bindweed and perennial sow thistle, which emerged rather later, were apparently undamaged. Even at 1¼ pounds application a few corn plants were found with typical 2,4-D symptons. (Contributed by Division of Plant Science, The University of Manitoba.)

Use of 2,4-D for chemical summerfallow. Pavlychenko, T. K. On July 18, 1946, four 6' x 12' plots were treated with methyl ester at the rates 1/2, 1, 1-1/2, and 2 lbs. of acid equivalent per acre. In addition a field one acre in size was sprayed with 1-1/2 lbs. per acre of the same chemical. The plots and the field were heavily polluted (120 to 450 plants a sq. yd.) with wild mustard (Sinapis arvensis) and stinkweed (Thlaspi arvense). Counts were made every 30 days after the treatments and late in May, 1947. The results were as follows: Records taken 30 and 60 days after treatment showed 100 percent kill of the top growth in all plots. One month later the new seedlings of Russian thistle emerged and grew till freeze up in various plots to the extent of 1 to 8 percent of the original weed stand. In May 1947, the Russian thistle, redroot pigweed, wild mustard and stinkweed were present, their aggregate population amounting from 14 to 38 percent of the original stand. Of this total Russian thistle constituted not less than 90 percent in all plots. (Contributed by Laboratory of Plant Ecology, University of Saskatchewan.)

The effect of intensive cultivation of field bindweed before and after spraying with 2,4-D on efficiency in eradication. Timmons, F. L.* An experiment comparing 2,4-D spraying alone, intensive cultivation alone, and four different combinations of the two as methods of eradicating bindweed was started at Hays, Kansas in the spring of 1947. The four combination methods included: intensive cultivation after spraying with 2,4-D in early spring; and intensive cultivation 1, 2, and 3 months, respectively, before spraying with intensive cultivation as needed after spraying with 2,4-D. Results to date from the uncompleted experiment show no advantage for intensive cultivation either before or after spraying with 2,4-D. A single cultivation before spraying to eliminate grasses and other early starting weeds and conserve moisture appeared desirable. Emergence of bindweed plants after periods of intensive cultivation was slow and erratic and may not have been completed during the four to six weeks of growth before spraying. Intensive cultivation was not effective in eradicating the bindweed plants which survived treatment with 2,4-D. A single spraying with 2,4-D with no intensive cultivation reduced the stand of bindweed slightly more than did one season of intensive cultivation involving ten tillage operations. However, the amount of soil moisture conserved by the former was much less due to the growth of grasses and other annual weeds not controlled by 2,4-D. (*Agronomist, Bureau of Plant Industry, Soils and Agricultural Engineering, USDA, cooperating with the Fort Hays Branch of the Kansas Agricultural Experiment Station.)

The effect of shoot cutting of field bindweed at different intervals after spraying with 2,4-D upon the effectiveness of the spray treatments. Timmons, F. L.* An area uniformly infested with bindweed was sprayed June 16, 1947, with the butyl ester of 2,4-D at 1.3 pounds of 2,4-D per acre. The

sprayed plants on duplicate plots were undercut at a depth of four inches 1, 4, 9, 14 and 21 days, respectively, following the spray treatment. The sprayed plants showed only slight visible effects of 2,4-D one day after spraying and all leaves and stems were still alive although showing typical effects of 2,4-D nine days after spraying. All top growth was dead 21 days after spraying. Plant counts made August 22 showed a regrowth of 20 percent of the bindweed on the plots cultivated one day after spraying, nine percent on plots cultivated four days after spraying and only 1 to 1.5 percent on plots cultivated 9, 14 or 21 days after spraying or not undercut at all. The results indicated that the effect of 2,4-D was transmitted to the roots of bindweed so rapidly that some retardation of regrowth had taken place in one day and the maximum translocation had occurred within nine days. (*Agronomist, Bureau of Plant Industry, Soils and Agricultural Engineering, USDA, cooperating with the Fort Hays Branch of the Kansas Agricultural Experiment Station.)

The effectiveness of different combinations of intensive cultivation and growing competitive crops with 2,4-D treatment in eradicating field bindweed. Timmons, F. L.* Experiments started in 1946 and 1947 compare twelve different methods of using one or two 2,4-D treatments of bindweed each year in combination with intensive clean cultivation and growing competitive crops of wheat, barley, milo, close drilled sargo, Sudan grass or buffalo grass. All treatments are duplicated and a part of each plot is not sprayed, but otherwise handled as the sprayed part of the plot. In most of the methods the sprayed and unsprayed parts of each plot are cultivated intensively between crops as necessary to prevent recovery of bindweed regrowth except when the bindweed is sprayed. Preliminary results indicate that several of the combination methods are more effective in controlling and eradicating bindweed than is repeated spraying with 2,4-D. Complete eradication of bindweed was accomplished in two years with some of the methods. Bindweed regrowth from 2,4-D treatment appears to require as much or more intensive cultivation to complete eradication than unsprayed bindweed. In all cases where bindweed was sprayed in the growing crop the yields were considerably lower on the sprayed part than on the unsprayed part of the plot. Where the bindweed was sprayed before the crop was planted yields usually were higher on the sprayed part. Best results to date have been obtained from spraying with 2,4-D in the fall and seeding a small grain or sorghum crop in the spring. Spraying in spring followed by late seeded sorghum crops also appears promising. (*Agronomist, Bureau of Plant Industry, Soils and Agricultural Engineering, USDA, cooperating with the Fort Hays Branch of the Kansas Agricultural Experiment Station.)

RESULTS OF EXPERIMENTS WITH MISCELLANEOUS HERBICIDES

REGIONAL SUMMARY

E. D. Witman

Isopropyl-n-phenyl carbamate (IPC) has generally given only disappointing results in the control of perennial grass.

Ammonium trichloroacetate (ATCA) appears very promising for the control of quack grass, Bermuda grass, Muhlenbergia mexicana, Johnson grass, Tripsacum dactyloides and annual grasses. Applications of from 100 to 400 pounds per acre

are effective especially when moisture is adequate. Soil effects may last longer than 70 days under dry conditions.

ABSTRACTS

Destruction of quack grass rhizomes by applications of isopropyl-n-phenyl carbamate. Carlson, R. F. Preliminary studies with IPC (Isopropyl-n-phenyl carbamate) in the greenhouse indicate that it is effective in destroying quack grass when it is applied to the rhizomes (underground stems). The leaves of this plant were injured little, if any at all, when sprayed with 1,000 ppm of this compound, but the rhizomes failed to regenerate new shoots when treated with concentrations between 500 ppm and 1,000 ppm. IPC apparently is selective in action because it does not harm many of the broad leaved plants and germinating seed of some plants. It is effective on seedlings of certain cereal crops. Soil treatment was also effective in destroying underground stems of quack grass. Actual field experiments with this material indicate that quack grass can be controlled if direct contact is obtained with the underground stem. Twenty pounds to the acre gave good control where the underground stems were sprayed after being dragged to the surface. The check plots soon recovered, while the treated plots showed very little recovery. Method and time of application are factors which are important and need some consideration in order to obtain maximum results. This will vary with the location and temperatures. (Contributed by Michigan Agricultural Experiment Station, Section of Horticulture.)

Effect of ammonium trichloroacetate on Johnson and Bermuda grasses. Elder, W. C.* Twenty percent ammonium trichloroacetate was applied at monthly intervals, beginning in June, at the rate of 1/4 lb. and 1/2 lb. per 100 sq. ft. on Johnson grass and Bermuda grass in 1947. The material was mixed with water and sprayed on the grass at the rate of 1 gal. per 100 sq. ft. All vegetative growth was killed in 4 or 5 days after application. June treatments seemed to give much better results than later applications. This was probably due to good moisture conditions in June. All other treatments were made when soil was very dry. June treatments gave almost 100 percent kill on Bermuda grass. Johnson grass made a 50 percent regrowth from roots 50 to 60 days after treatment. There seems to be little difference between 1/4 lb. and 1/2 lb. treatments. Weaker concentrations should be tried on Bermuda grass. Winter cereals and legumes were planted on the plots 90 days after June treatments and all crops are making normal growth. Some of the winter cereals and legumes planted on the plots 70 days after the July treatments did not germinate. (*Assistant Agronomist, Oklahoma A & M College.)

The effectiveness of ammonium trichloroacetate and isopropyl-n-phenyl carbamate in eradicating Bermuda grass. Timmons, F. L.* Ammonium trichloroacetate was applied May 16, 1947, as concentrated sprays at rates of 1/8, 1/4, 3/8, 1/2 and 3/4 pound of active ingredient per 100 square feet (54, 109, 164, 218, and 327 lbs. per acre) on Bermuda grass from which the top growth had been removed to a height of one inch. The soil was wet when the chemical was applied and 8.60 inches of rain were received before June 20, when the percentage kills of Bermuda grass recorded were 50, 85, 97, 99 and 100 respectively, for the five rates of treatment. Observations made September 3, showed that recovery of Bermuda grass had occurred only on the plots receiving the lightest treatment. Dandelions were not killed by the heaviest treatment. Annual weeds germinated immediately after the treatments on all plots and made normal growth.

Similar treatments of ammonium trichloroacetate were made July 29 on Bermuda grass in comparison with isopropyl-n-phenyl carbamate which was applied in mixture with fine dry sand at 5, 10 and 20 pounds of active ingredient per acre. The soil was extremely dry when the chemicals were applied and only 2.36 inches of rain was received as light showers during the next 90 days. Percentage kills of Bermuda recorded October 24, 1947 were 65, 75, 97 and 99, respectively, for ammonium trichloroacetate at 109, 164, 218 and 327 pounds per acre. The isopropyl-n-phenyl carbamate produced no noticeable injurious or other effect on the Bermuda grass at any rate of application. (*Agronomist, Bureau of Plant Industry, Soils and Agricultural Engineering, USDA, cooperating with the Fort Hays Branch of the Kansas Agricultural Experiment Station.)

Effect of ammonium trichloroacetate on quack grass. Willard, C. J., and Neville, Homer B. Mr. G. L. McCall, of the DuPont Company, furnished us with a sample of 20 percent solution of ammonium trichloroacetate for trial on quack grass. This was applied on July 8th and 9th on vigorous quack grass sod which had been plowed about June 20th and a vigorous, fresh, young stand of quack grass was in evidence. The material was applied to square rod plots at rates approximating 125 and 250 pounds per acre. Both rates controlled quack grass nearly 100 percent. Even in October there were only occasional sprouts -- 2 or 3 to the square rod. The plots will be left until next spring for a further check of their condition then. Additional tests of late fall application are in progress. (Contributed by Ohio Agricultural Experiment Station in cooperation with E. I. DuPont deNemours & Company.)

Effect of isopropyl-n-phenyl carbamate on quack grass. Willard, C. J., and Neville, Homer B. An area of dense quack grass was plowed about June 20th and experiments on the use of isopropyl-n-phenyl carbamate started. The first tests were conducted immediately after plowing and working the ground down. Since the material was supposed to be toxic to the rhizomes, it was worked into the soil at 3, 5, 7 and 10 pounds per acre. These were all totally ineffective. A supply of 5 percent IPC dust was received and applied July 8th and 9th on the same area. The quack grass by this time had sprouted vigorously. Through a fortunate error, the dust was applied at a rate which put on 30, 50 and 100 pounds per acre of actual IPC instead of the 3, 5 and 10 pounds which were intended. On August 28th these plots were rated 75%, 95%, and 99% killed as compared to the check plots. However, by October the plot which had received 100 pounds per acre of IPC had a thin but uniform and healthy growth of quack grass all over it. Obviously, if the material is to be effective, it must be used in rates greater than 100 pounds per acre. Further experiments with applications on newly plowed land and on established quack grass are in progress. (Contributed by Ohio Agricultural Experiment Station in cooperation with the Dow Chemical Company.)

The effect of ammonium trichloroacetate on quack grass, Johnson grass, Bermuda grass, (Muhlenbergia mexicana), (Tripsacum dactyloides) and annual grasses. Zahnley, J. W. The above grasses, except the annuals, were mowed, the hay removed and the sod sprayed with ammonium trichloroacetate solution in water June 25, 1947. When mowed, the quack grass was past bloom and forming seed, Johnson grass was 2-1/2 feet high in pre-boot stage, Bermuda had been kept clipped, Muhlenbergia in pre-boot stage, and Tripsacum in boot stage. All plots were 10 x 10 feet and received one gallon of solution. Rates used were

1/4, 1/2, 3/4 and 1 pound on quack grass and Bermuda; 1/4, 1/2 and 3/4 on Johnson grass; 3/8 and 1/2 on Muhlenbergia and annual grasses; and 3/4 pound on Tripsacum. On September 1, 1947, the quack grass, Bermuda, Muhlenbergia and annual grass showed complete kills on all plots. A few plants remained alive on all the Johnson grass plots and on the one plot of Tripsacum, but by October 15 some of these were dead and others were very weak. Treatment of Johnson grass without previous mowing appeared to be as effective as treating the stubble after mowing. The treated plots of Muhlenbergia were given light surface tillage and planted to a mixture of Blue grass and alfalfa September 15. Normal stands of both were obtained. (Contributed by Kansas Agricultural Experiment Station, Manhattan, Kansas.)

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